SAE Journal

DECEMBER 1956

IN THIS
AUTOMOBILE SHOW ISSUE . . .

Trends in 1957 Car Design

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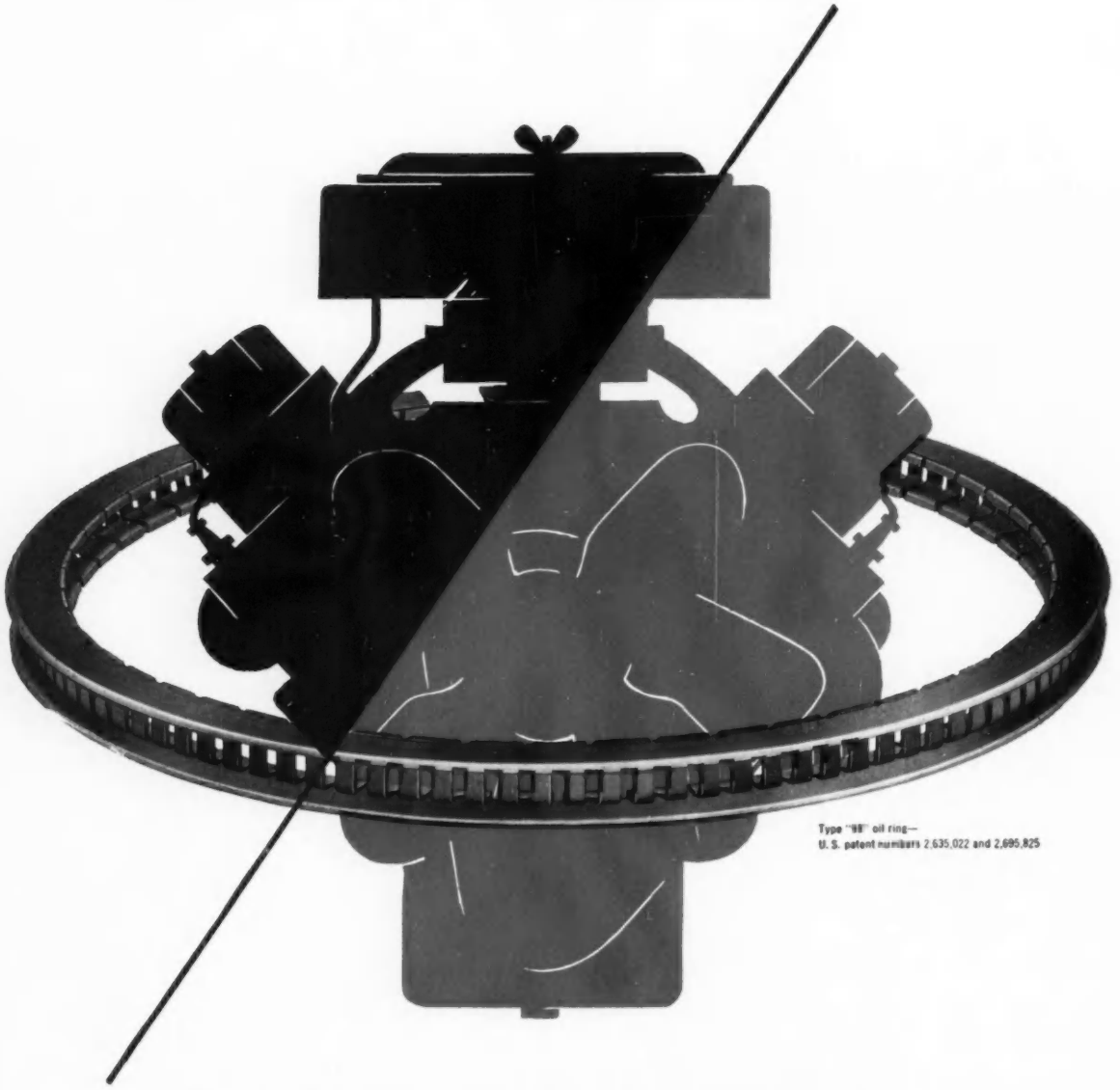
Published by The Society of Automotive Engineers

More than half*...



Type "98" oil ring—
U. S. patent numbers 2,635,022 and 2,695,825

of the 12,614,000 passenger car engines produced in the U. S. from January 1, 1955 through November 3, 1956 were equipped with

PERFECT CIRCLE

type "98" chrome oil rings

"Best for New Engines...Essential for Worn Engines"

*54% were Perfect Circle Type "98" chrome oil rings. 46% were all other oil ring types combined, including other Perfect Circle oil ring types.

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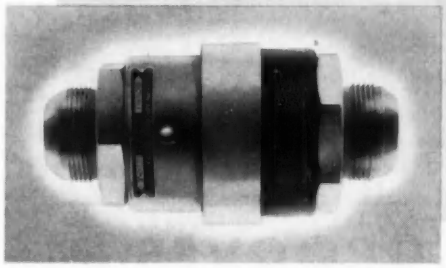
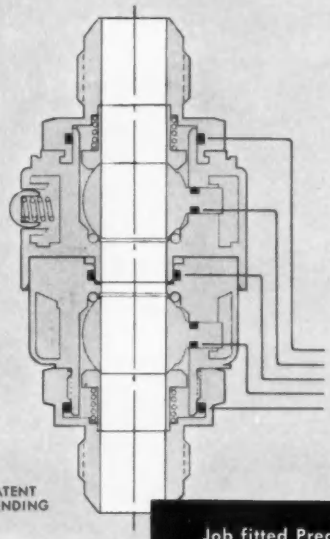
ZERO LEAKAGE

Precision "O" Rings answer another sealing problem

Precision "O" Rings in the Eastern Aircraft quick disconnect coupling seal perfectly under pressure of 4000 P.S.I. and over the temperature range of —65° to 275°F.





PATENT PENDING

Job fitted Precision "O" Rings have solved hundreds of other industrial aircraft and automotive sealing problems.

Rigid quality controls maintained at Precision are paying off both for Precision and their customers. A case in point is the development of a quick disconnect coupling by Eastern Aircraft Products Corporation of Orange, New Jersey. Precision engineers developed "O" Ring compounds for these straight through couplings which eliminate pressure drop, and provide zero leakage. The result—a super quick, self-sealing, trouble-free coupling sealed at both ends for the aircraft, petroleum and chemical industries.

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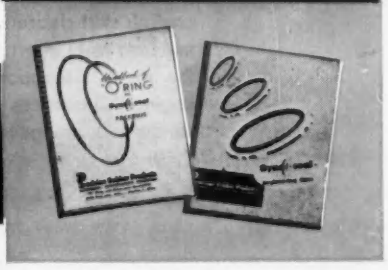

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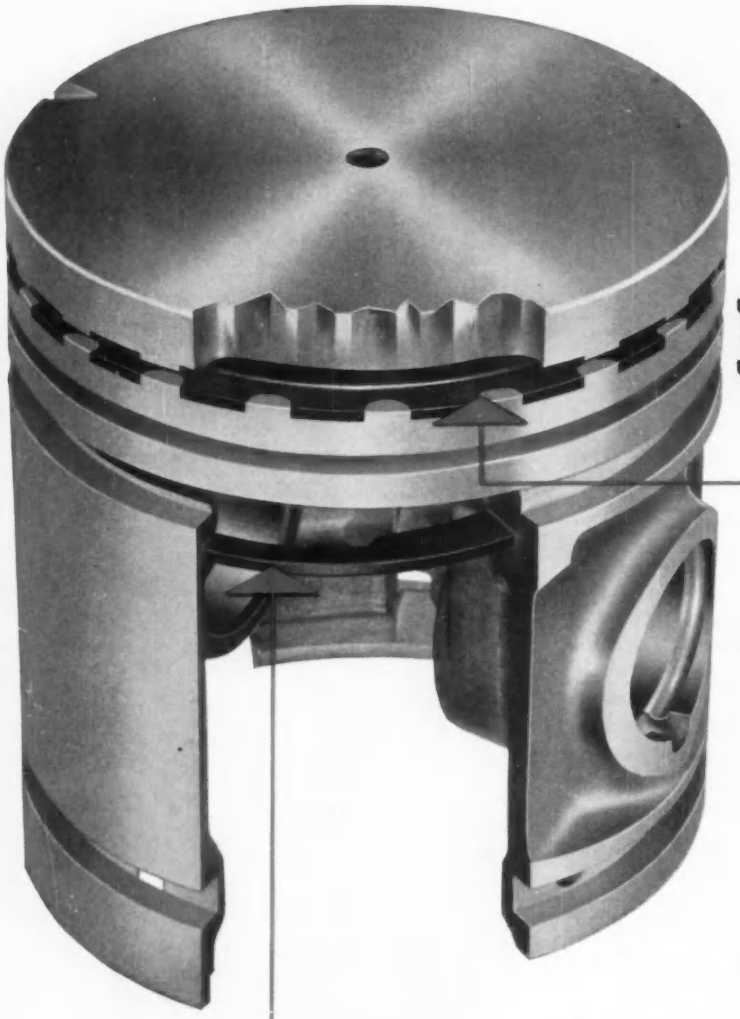

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are available with LOW COST Intra-Cast* STEEL-LINED GROOVES

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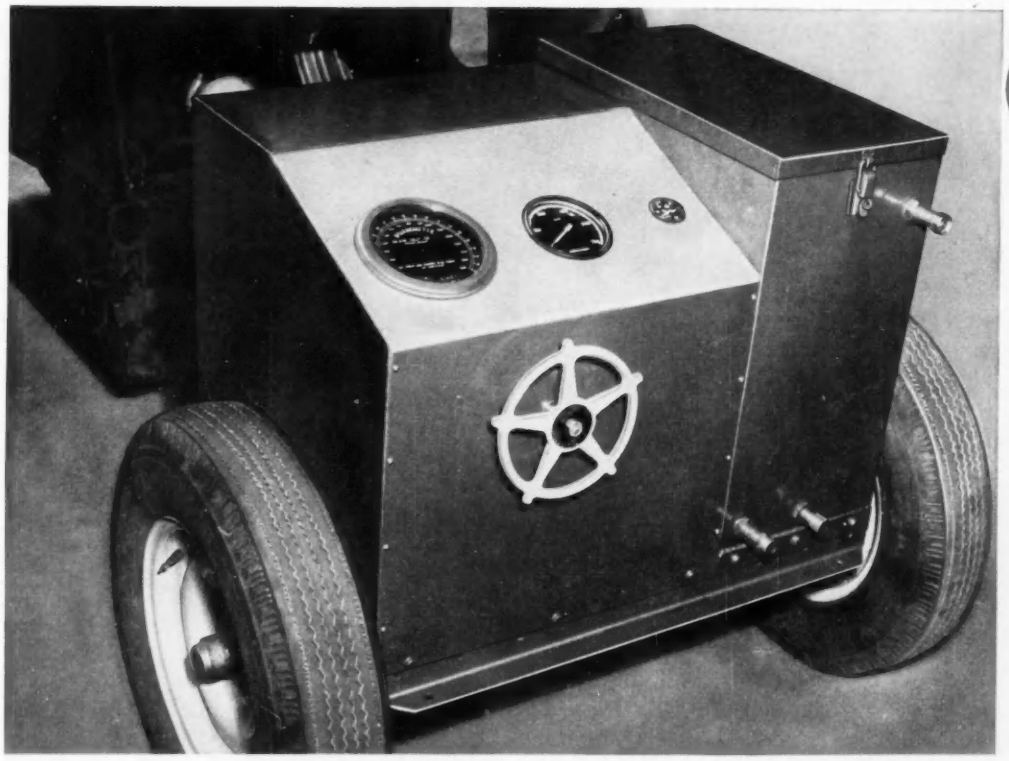


WHAT'S **NEW** AT BLOOD BROTHERS

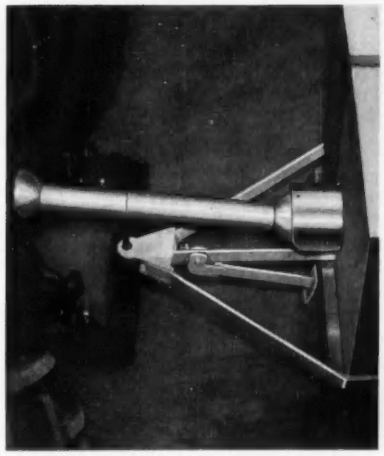
BLOOD BROTHERS P.T.O. Drive Lines

Selected by M&W GEAR CO., Inc. for

Exciting NEW TRACTOR-TESTING DYNAMOMETER

Tractor repairmen and dealers are enthusiastic about this new test unit because it meets a real need in the farm tractor field. The only machine of its kind on the market, M&W's new dynamometer brings actual field operating conditions into the shop. Mechanics can test the pull power of farm tractors and accurately adjust ignition, carburetion and engine speed under full load for peak performance and economy.

Here's another example of the preference shown by farm implement manufacturers for Blood Brothers Drive Lines. They're selected for almost all new developments and improvements by the progressive Implement Industry because of their field-proven dependability and superiority.



Blood Brothers Safety-Shield Drive Line handles torque loads easily—and protects mechanics working in close quarters around tractor and dynamometer in garage or implement repair shop.

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED.

TAKES POWER AROUND CORNERS

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UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

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The answer lies in an individual *evaluation of your application.* Garter springs, where not required, can take a "free ride" at your expense. The mechanical action created by garter springs can result in excessive torque and friction . . . can often shorten seal life . . . can actually cause shaft wear.

IPC seals are designed, compounded and bonded to provide inherent resistance to operational stress, *often without the added cost of mechanical "pinch".*

If excessive eccentricity, temperature range or other conditions do warrant the use of mechanical "pinch", IPC engineers will design your oil seal to combine custom compounding with minimum spring "pinch" consistent with good performance.

Before you buy, ask for IPC's recommendation.

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3. Bonded Washer Seal Straight Lip
11. Bonded Case Seal Straight Lip Thin Rind Type
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12. Bonded Case Seal Limited Contact Lip Thin Rind Type
5. Bonded Washer Seal Straight Lip With Garter Spring
13. Rubber Covered Bonded Case Seal Straight Lip
6. Bonded Washer Seal Limited Contact Lip With Garter Spring
14. Rubber Covered Bonded Case Seal Limited Contact Lip
7. Bonded Case Seal Straight Lip
15. Rubber Covered Bonded Case Seal Straight Lip With Garter Spring
8. Bonded Case Seal Limited Contact Lip
16. Rubber Covered Bonded Case Seal Limited Contact Lip With Garter Spring

P6

Make in the U.K. and sell to new markets

The E.N.V. organisation of London, England, invites the collaboration of an American manufacturer seeking new markets in Britain, Europe and the British Commonwealth.

World famous for spiral bevel gears, hypoid drives and associated transmission components, E.N.V. has two modern plants, covering over 250,000 sq. ft. and employing more than 1600 operators.

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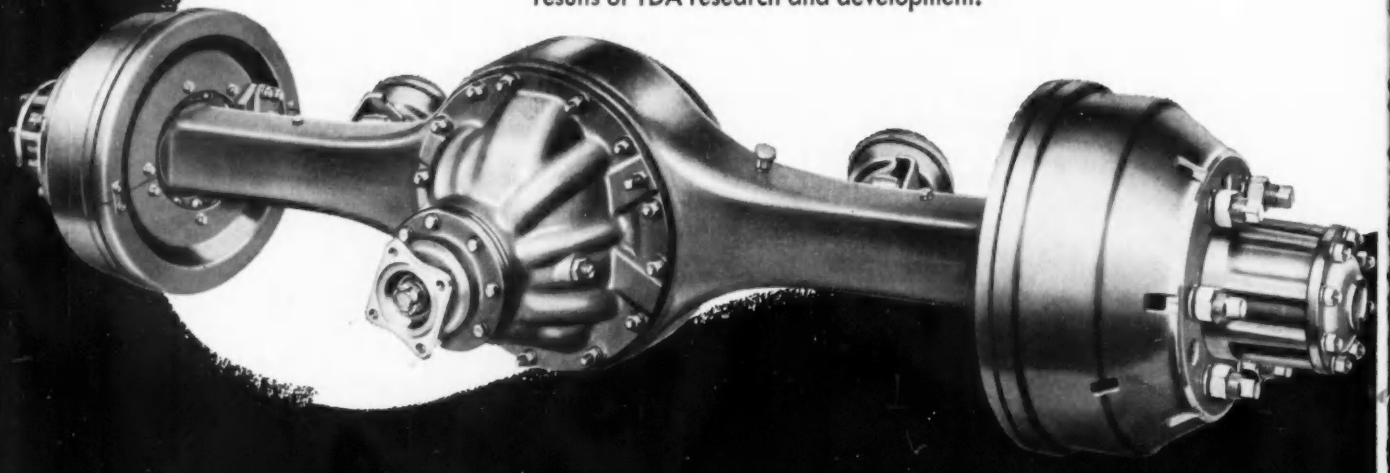
World's Largest Manufacturer of Driving Axles for Medium and Heavy Duty Commercial Vehicles

In its many years of service to American industry, Timken-Detroit® has produced more than 6,300,000 driving assemblies for powered vehicles (industrial, agricultural or automotive). The "Ten Automotive Firsts" on the opposite page are but a few of the significant results of TDA research and development.



these 10 Automotive Firsts have established TDA® leadership

in producing over

5,000,000

Driving Axles for America's Trucks and Busses

plus 1,300,000 for other powered units!

1. Tandem Driving Axles—TDA developed the first tandem driving axles for the industry to increase the capacity of vehicles.

2. The Double-Reduction Axle (both single and two-speed types)—TDA developed the first double-reduction axles, principally to permit higher axle shaft torque values for nominal pinion input torques.

3. The 3-for-1 Axle—TDA introduced the principle of interchangeability of three optional drives in the same housing . . . single-reduction . . . single-speed double-reduction . . . and two-speed double-reduction.

4. Heavy-Duty Hypoid Gearing—This successful TDA innovation made possible larger, stronger, longer-wearing pinions of greater torque capacity for the same tooth load at the pitch line than corresponding spiral bevel pinions.

5. The Power-Shifted Two-Speed Axle—TDA's power-shift made the two-speed axle universally acceptable. It simplified driver operation, providing improved vehicle control and safety.

6. Unit Mounted "P" Series Power Brake—This highly efficient, compact, easily maintained air brake with lightweight fabricated steel shoes has all parts "unit mounted" on a spider.

7. Tapered Brake Linings—TDA "Econo-Liner" tapered brake linings, first to offer maximum thickness in the area of greatest wear which resulted in uniform thickness when worn.

8. First 100,000 Mile Guaranteed Axle Shaft—Torsion flow forging, controlled gradient hardness heat treating and shrouded spline design make the TDA shaft the best in the industry; first to be guaranteed for 100,000 miles.

9. The Tubular Trailer Axle—TDA adapted the tubular form to trailer axles to make a lighter, stronger axle than any previously available.

10. The "Wide Range" Two-Speed Axle—TDA was the first to develop two-speed axles with ratios of 2 to 1 and 2½ to 1 between the upper and lower ranges, to overcome the basic limitations of mechanical and automatic transmissions.

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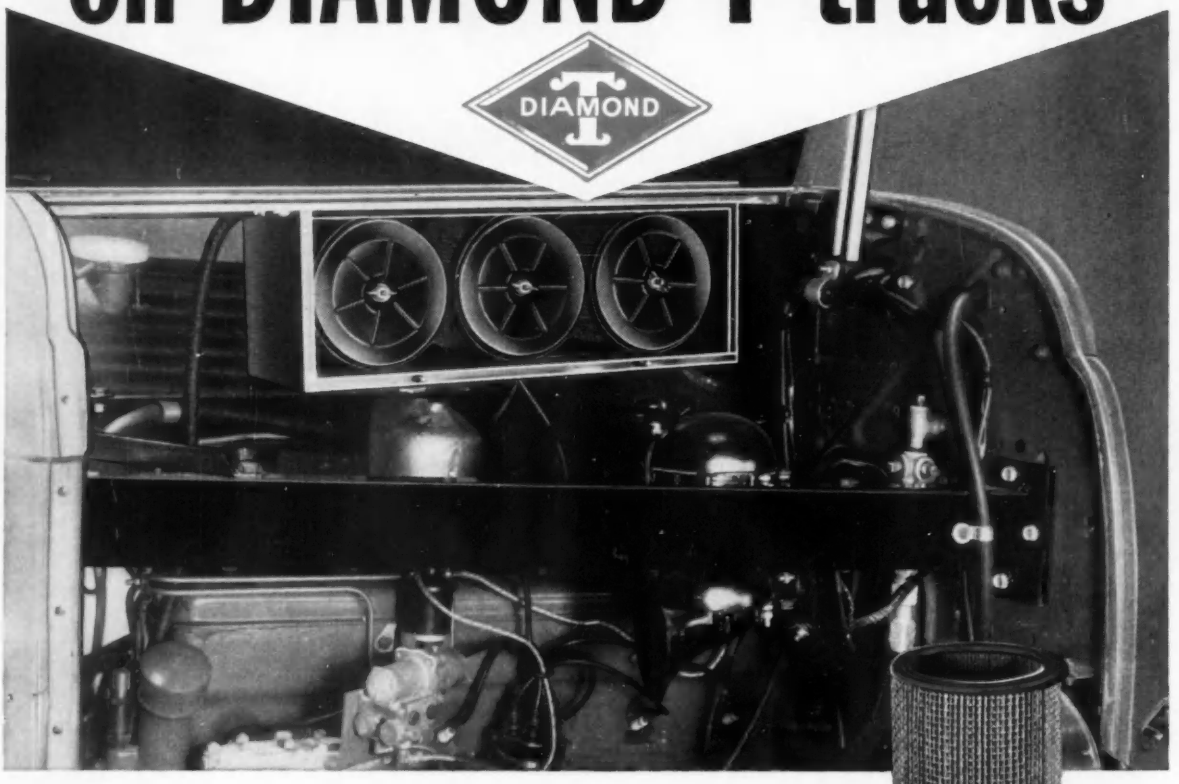
now standard equipment on DIAMOND T trucks

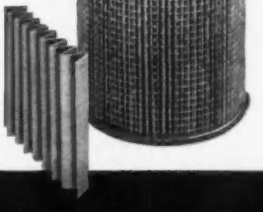


3 FRAM *Filtronic* Carburetor Air Filters—99.+% efficient—cut engine wear, guard power

Now famous Diamond T truck engines enjoy the protection of FRAM FILTRONIC Carburetor Air Filters, to preserve power, reduce wear and lengthen life. FRAM will safeguard these Diamond T engines even under the most severe dust conditions.

The FRAM FILTRONIC Carburetor Air Filter is the most advanced method of air filtration. It retains high filtering efficiency throughout long life and its low-cost replacement cartridge can be serviced in less than a minute!

FRAM FILTRONIC Carburetor Air Filters on your vehicles will cut down-time, add extra miles and pay off in profit.



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The drafting stage—not later—is the time to design-in oil seals!

Oil seals are precision products. They are designed to operate under a specific set of conditions. Change just one of those conditions—lubricant, shaft speed, temperature, even bearing position—and a different seal will almost always be needed.

Why chance costly retooling or remanufacture? Specify the correct seal on the drawing-board. And when you do, get all the information there is on new seals, new lip compounds, and mechanical designs. Get it from your National Oil Seal Engineer. His counsel is complete, up-to-the-minute, and accurate. You couldn't buy better oil seal information, yet his help is yours for the asking.

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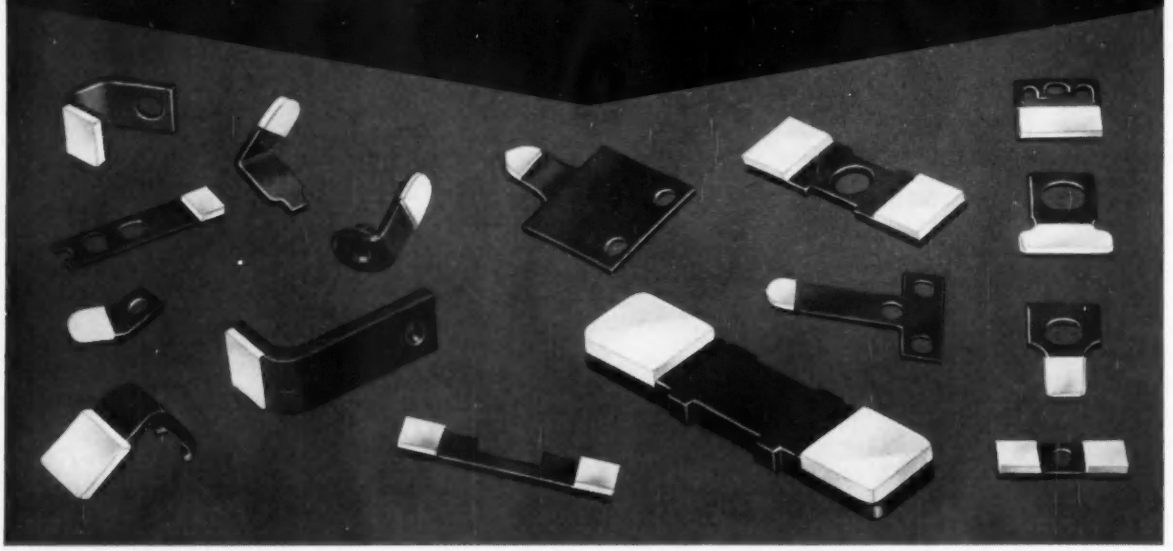

General Plate development and volume production of Silver-Cadmium Oxide clad as TOP-LAY now means you can get all of the advantages of Silver-Cadmium Oxide and TOP-LAY combined:

- ★ **Silver-Cadmium Oxide, properly applied, is an outstanding contact material — unusual in its ability to resist arc damage.**
- ★ **High work-hardness and density of both contact facing and backing, blanked or formed from TOP-LAY reduces mass and deformation . . . prolongs contact life.**
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- ★ **The problems of brazing — atmospheres, cleaning and fixturing — are eliminated.**

These Silver-Cadmium Oxide TOP-LAY advantages, plus the many other advantages offered by General Plate clad metal contacts, produce assembly accuracy, design freedom, substantial cost reductions and performance improvements.

Benefit today from General Plate's new Silver-Cadmium Oxide TOP-LAY . . . for complete information, write for Bulletin 728.

You can profit by using General Plate Composite Metals!

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GENERAL PLATE DIVISION
1112 FOREST STREET, ATTLEBORO, MASSACHUSETTS

For the Sake of Argument

"Don't Apologize . . ."

By Norman G. Shidle

"Don't apologize for what you are about to say. Just say it." Thus we overheard an executive admonish an associate the other day.

In the exchange which followed, the exhorter developed his theme—chiefly in response to apologies for apologizing! Put together, he argued about like this:

"Long apologetic windups before letting listeners know the subject wastes listeners' time. It bores them to death, too. Neither a funny story nor a business statement profits from an I-probably-shouldn't-say-this introduction. Same thing goes for 'You probably know this, but I'm going to tell you anyhow'; 'You probably won't agree with this, but . . .'; and all the train of apologia they drag behind them.

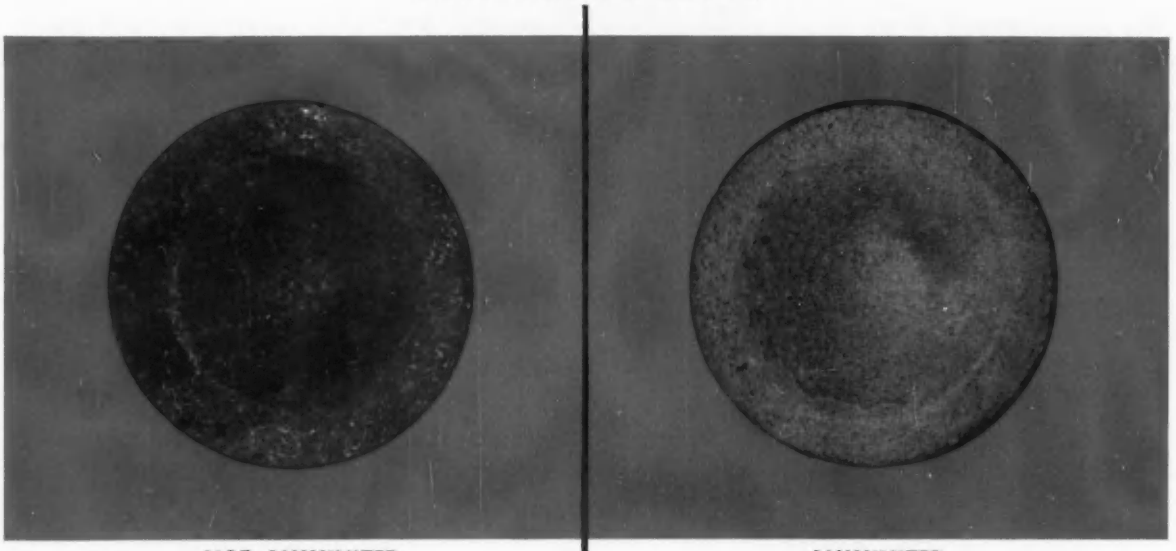
"Take the authorities on how to write, who urge us to begin our writing with a specific statement of the main idea we want to leave with the reader. Why, I know at least one of these fellows who consistently does just the opposite almost every time he talks. He's meticulous about avoiding apologetic gambits in his smallest bit of writing. But, he sometimes talks for a whole minute before he lets me in on what he's talking about.

"If apologies are really needed for what you are about to say, you had probably best leave it unsaid. . . . Otherwise, no apology is needed."

As the executive finished speaking, we ceased our notetaking and quietly slunk away . . . a wiser, if not a better, man.

The EATON Process of Aluminizing Exhaust Valve Heads PREVENTS PRE-IGNITION

CAUSED BY INCANDESCENT SCALE



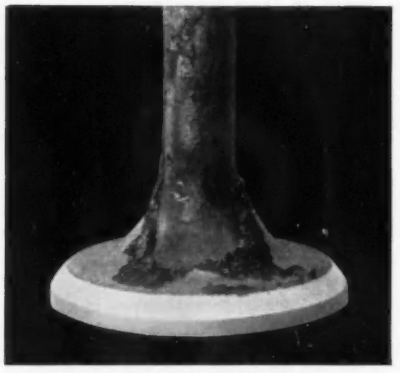
NOT ALUMINIZED
Note Scale which Promotes Pre-ignition

ALUMINIZED
Absence of Harmful Scale Prevents Pre-ignition

Conventional exhaust valve steels, run at high temperatures, tend to corrode and scale, promoting damaging pre-ignition. This condition can be overcome by the use of expensive high-alloy materials. However, there is a simple and less expensive solution to the problem. By applying the Eaton aluminizing process to conventional exhaust valve steel, resistance to corrosion and scaling can be increased tremendously, thereby eliminating a condition which can be a major cause of pre-ignition.

Inlet valves conditioned by the Eaton aluminizing process also are contributing to the increased efficiency, dependability and service life of engines.

Our Valve Division engineers will be glad to discuss the application of Eaton aluminized valves to your engines. Send for illustrated literature.



Aluminizing of Inlet Valve Seat-Face Prevents Oxidation

After aluminizing by the Eaton process, this plain carbon steel valve was placed in an air atmosphere furnace at 2000°F. for 16 hours. Gross oxidation of the base steel resulted. The aluminized seat-face and margin areas were unaffected.

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ADVERTISING OFFICES
E. D. Boyer
Eastern Advertising Manager
485 Lexington Ave.
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Midwestern Advertising Manager
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R. C. Sackett, Staff Representative
808 New Center Bldg.
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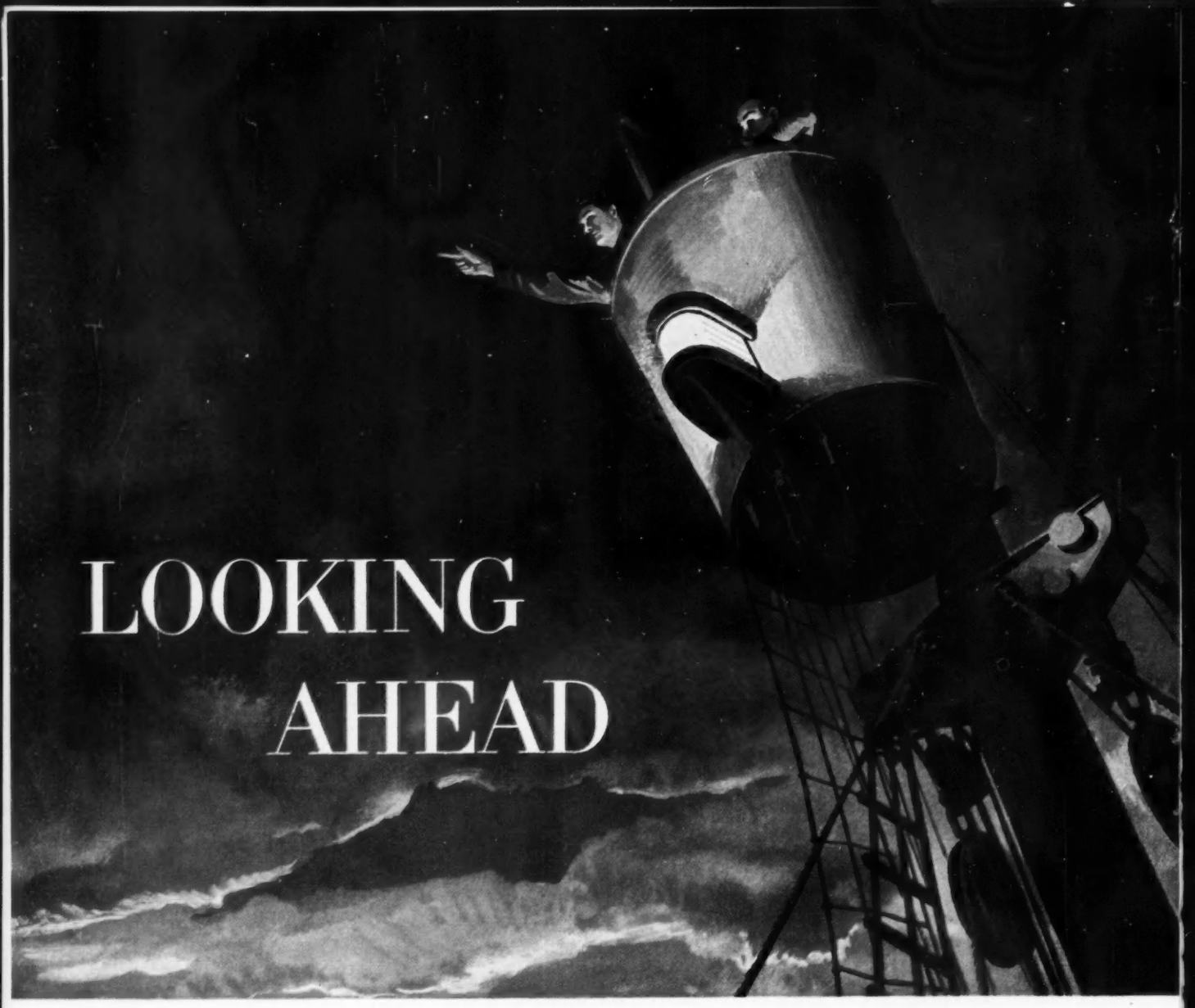

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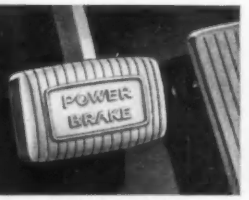

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Trends in 1957 CAR DESIGN

Thomas A. Bissell
Manager, Meetings Division
Society of Automotive Engineers

Written with the cooperation of the SAE Passenger Car Activity Committee, this paper was presented at the SAE Dayton Section, Dec. 4, 1956; SAE Atlanta Section on Dec. 6, 1956; and will be presented at SAE Syracuse Section on Jan. 8, 1957.

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FOUR main trends dominate the design of the new 1957 passenger cars. They are lower, more powerful, safer, and more comfortable. To make them this way has required a fabulous number of engineering man-hours and a cash outlay that probably exceeds a billion dollars. Both the investment and the results top anything that has gone before.

Various and ingenious means were employed to solve the problems necessary to reach these goals. This paper is an attempt to tell how it was done.

The job of lowering cars by as much as five inches, for example, affects the design and arrangement of just about every component in the car from bumper to bumper, from roof to tires. Increasing the power and performance of the engine, and the safety and comfort of passengers, also influence the design of a host of related parts.

Brand new cars bristle with new components and

design features, including many industry "firsts," such as a fuel injection system, a retractable hardtop, a model with curved glass side windows, four-lamp dual sealed-beam roadlighting system, and 14-in. tires, wheels, and rims.

Information on Cadillac's *avant garde* design, the 1957 Eldorado Brougham, and the 1957 Packard models of Studebaker-Packard Corp., was not available when this paper went to press. The Eldorado Brougham is said to incorporate fuel injection, air springs, four-lamp headlights, a frame of unorthodox design, and a pillarless four-door construction with the rear doors hinged from the rear. (Papers covering the new frame and new suspension are scheduled for presentation at the 1957 SAE Annual Meeting and the 1957 SAE National Passenger Car, Body, and Materials Meeting, respectively . . . and for early abridgments in SAE Journal.)

Bodies . . .

. . . are lower, longer, and wider; have more glass with extended wrap-around; larger, higher, canted tail fins; more conservative colors; 14-in. wheels and tires; and feature emergence of hardtops as the dominating body type.

FORD's retractable hardtop and Chrysler Imperial's curved side windows establish new firsts for American production cars. New bodies have been introduced by Buick, Cadillac, Chrysler, DeSoto, Dodge, Ford, Imperial, Mercury, Oldsmobile, and Plymouth—more than in any previous model year.

Cars have been lowered so much that a woman of average height would have little difficulty in seeing over any one of them. Only one or two of them are over 60 in. high. They average about 3 in. lower. Probably the biggest drop and one of the lowest hardtops is the Plymouth with a loaded overall height quoted at 54 in.—over 5 in. lower than the 1956 Plymouth.

The trend toward longer bodies has slowed, with many slightly longer; some are virtually the same in overall length, and at least one is actually shorter. That one is the Chrysler Imperial; its 224 in. overall length is 5.6 in. less than in 1956. Almost every new body is wider than its predecessor—by as much as 3.6 in.

Greater Glass Area

Virtually every 1957 model will have a greater glass area, and this increase is greatest in the windshield where it will contribute the most to safety and ease of driving. Windshield area increases go all the way up to the 48% quoted for the Chrysler Imperial's windshield (Fig. 1) that wraps around into the roof as well as into the sides and hood.

The steel top of Ford's retractable hardtop is fully retracted and concealed in the luggage compartment, at the touch of a button, in about 30 sec.

The nerve center of the retractable top is composed of 7 motors and 10 relays actuated by 12 limit switches.

A cycle of operation (see Fig. 2) entails the automatic opening of the deck lid, retraction of the roof into the deck, and return of the deck lid to the closed position.

Some Buick, Olds, and Cadillac bodies have three-piece backlights with two raised ribs starting at the rear of the deck lid and running the length of the roof to a stop at the windshield header. Mercury Turnpike Cruiser features a retractable backlight that stows behind the rear seat back. A projection is provided over the backlight to shield passengers.

Door handles recessed into the body for safety, appear on all 1957 Imperials, Chryslers, Dodges and DeSotos. An upward motion of the handle unlatches the door.

Pontiac will use a thermosetting plastic finish as standard on custom models. Unusual resistance to effects of extreme conditions are claimed for the finish.

The Cadillac Eldorado carries a three-section rear bumper. The center houses the license frame, plate, and light. Each outer section contains a round exhaust opening and matching back-up lamps. The outer sections curve

Fig. 1—The 1957 Chrysler Imperial exemplifies many 1957 body and styling trends—low body; greatly increased glass area with "double-wrap-around" windshield and curved side windows; larger, higher tail fins; 14-in. wheels and tires; dual headlamps; door handles recessed into body; and anodized aluminum radiator grille.

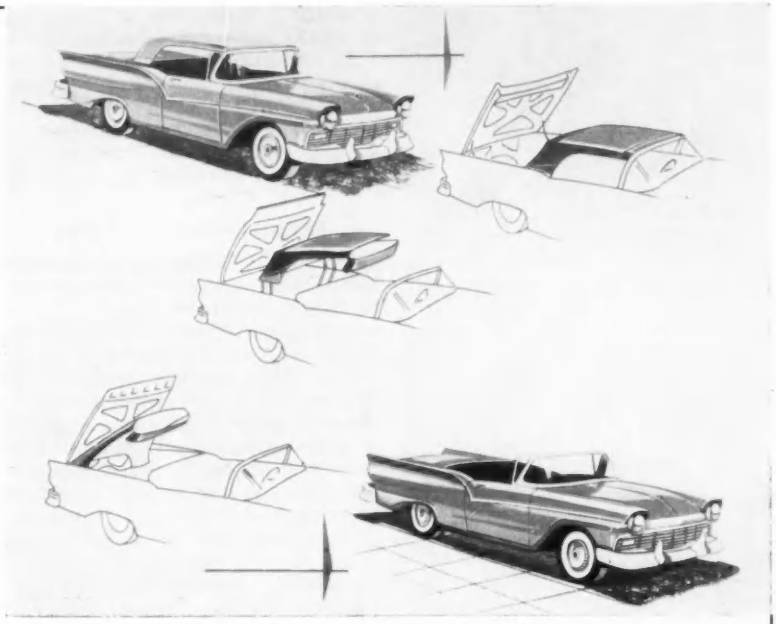


Fig. 2—Operation of Ford retractable hardtop.

The single control necessary for operation of the top is a conventional convertible-top switch which is spring-loaded for automatic return to the OFF position. An indicator lamp, actuated by the deck lock mechanism, is lighted except when the deck lid is closed and locked.

The retraction cycle is started by first placing the transmission gear-shift lever in neutral, then pulling the top-control switch. The deck-unlock motor is put into operation, thereby releasing the lid from its mountings. A limit switch then actuates the deck open motor. When the deck is fully open, a limit switch performs three functions: first, it stops the deck-open motor; next, it actuates the tray-retract motor; and finally, it closes the circuit to the roof- and tray-erect motors, allowing the cycle to be reversed if necessary.

When the tray is retracted, a limit switch starts the roof-unlock motors. The roof motor, activated by a limit switch in the roof-lock mechanism, lowers the roof into the deck. The roof-unlock motors are stopped by the roof-position switch that starts the deck and deck-lock motors. When the deck lid reaches a predetermined point in its descent, it opens a limit switch that stops the deck motor. The deck is then locked, and the warning light goes out, signaling the release of the top-control switch.

around, extending to the rear wheel openings. Bumper guards are provided with rubber tips.

There is a definite trend toward anodized aluminum radiator grilles and use of this material for decorative parts formerly chrome-plated. 1957 models carrying aluminum grilles include Chevrolet, and Chrysler Corp.'s entire line.

Dodge and Plymouth position their parking-turning signal lights horizontally beside the headlights and toward the center of the car, giving the appearance of dual headlights except that the inboard units are somewhat smaller in diameter. Chevrolet has repositioned its ventilation air intakes so that they cap the headlights in the front fenders.

Engine Designs . . .

. . . have been modified to raise the horsepower of the same basic engines by as much as 20%. About every known device—and some heretofore unknown ones—have been used.

AN interesting example is how the Chevrolet Corvette engine was made to deliver the 1 hp per cu in. of displacement claimed for it. It was achieved with "Ramjet" fuel injection (described under "Fuel Systems"); an increase in displacement of 18 cu in. to 283 cu in.; an increase in compression ratio to 10.5/1, the highest on record; a higher lift camshaft; and mechanical valve lifters. The higher displacement was obtained by increasing the cylinder bore by 0.125 in. to 3.875 in., stroke remaining the same at 3 in. This engine is available as an option in the Corvette and throughout the Chevrolet passenger line. With two available displacements and various combinations of compression ratio, camshafts, valving, fuel injection or various carburetors, Chevrolet's basic V-8 engine can be made available in seven horsepower ratings from 162 to 283.

Top horsepower figure announced for an engine with a single four-barrel carburetor when this paper went to press is the 325

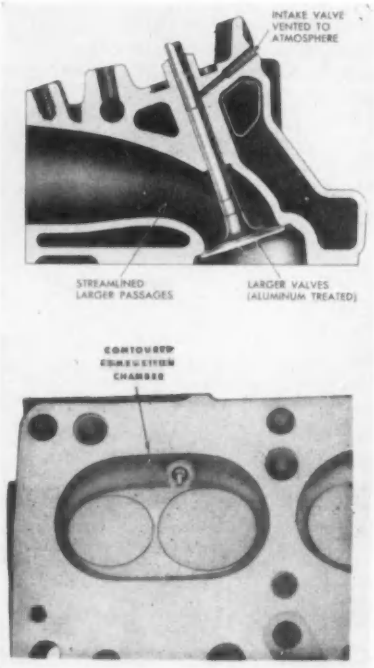


Fig. 3—Pontiac V-8 engine improvements.

hp for the Chrysler Imperial and New Yorker V-8 engine. This output was reached through increasing the displacement from 354 to 392 cu in., by enlarging the bore from 3.94 to 4.00 in., and by lengthening the stroke from 3.63 to 3.90 in.; through increasing the compression ratio from 9.0/1 to 9.25/1; through combustion-chamber refinements; and through improved breathing, including an increase in intake valve diameter to 2 in.

In addition to many other changes, such as the foregoing, Buick, Pontiac, and Oldsmobile have made interesting revisions in valves, valve train, camshafts, timing, and bearings.

Pontiac Vents Intake Valves

For the first time Pontiac intake valves are vented to the atmosphere as shown in Fig. 3. Vents are located between the intake valve stem and the valve stem guide. They are said to eliminate the possibility of vacuum within the intake passage from sucking lubricating oil into the combustion chamber through the clearance between the valve stem and the valve stem guide.

Buick Redesigns Camshafts

Buick camshafts have been redesigned to increase valve lift 0.045 in. The exhaust opening has been reduced 5 deg and the inlet opening increased 5 deg. The new camshaft profile is shaped to allow a more rapid opening of both intake and exhaust valves. Overall head diameters of intake and exhaust valves have been increased from 1.750 to 1.875 in. and from 1.375 to 1.438 in., respectively. The inner valve spring has been redesigned to provide an increase of total valve spring load of 7 lb with the valve open, and a decrease of 4.5 lb with it closed.

Oldsmobile also has revised its camshaft and the camshaft column and hydraulic valve lifter diameters have been increased. Exhaust valves are of MS-201 material said to have 15% greater hot strength than the material replaced. The crankshaft main bearing diameter has been increased from 2.5 to 2.75 in. Nos. 1, 2, 3, and 4 main bearings and connecting-rod bearings are of aluminum.

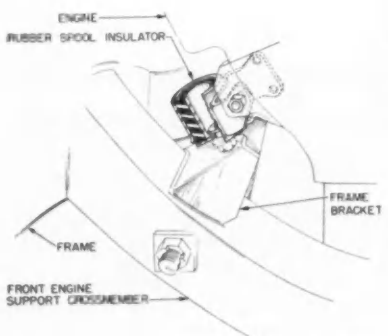


Fig. 4—Chrysler Corp. shear-type spool front engine mounting.

New V-8 For Rambler

The 1957 American Motors Rambler offers for the first time a V-8 engine. It is the same one introduced last year on the Nash Ambassador and Hudson Hornet except that solid tappets replace hydraulic lifters. The 1957 Rambler 6 engine incorporates a new variable-wedge type combustion chamber with a new three-ring wedge-top piston replacing the flat-top four-ring type.

Output of the seven basic engines of the Ford Motor Co. line has been increased in ways other than greater displacement, as bores and strokes remain the same. For example, the Mercury 312 cu in. V-8 now has a horsepower of 255, about 13% more than in 1956. This was accomplished by raising the compression ratio from 8.0/1 to 9.7/1; increasing the intake manifold passages, valve ports, and intake valve diameter; by a new high-lift camshaft, and by new two-venturi and four-venturi carburetors.

Studebaker also has increased the output of its engines without increasing displacements. On its Golden Hawk engine, it gets a big boost from its "Jet Stream" supercharger (described under "Fuel Systems"). Other devices used are higher compression ratios, new carburetors, and new fuel pumps.

Chrysler's Engine Mountings

Reduced shake, less noise, and less fore-and-aft engine movement are benefits claimed for the new shear-type spool front V-8 engine mountings introduced in the entire line of Chrysler Corp. (See Fig. 4.) The new mountings consist of a spool of rubber with steel shells on both outside and inside diameters. The outer shell is attached to the engine block and the inner shell is attached to the frame cross member. The rubber is not bonded to either shell but is free to move within the confines of the shells. Low-speed engine movement, which occurs during idling, is said to be damped effectively by the combination of rubber acting in shear, in compression, and in friction.

Buick's "nodal point" engine and transmission mounts have been increased in area to accommodate the greater torque. The mounts have been placed at an angle to the center of the crankshaft to utilize the low shear rate of the mounts. In the synthetic rubber compound used, the shear rate is 1/9 that of compression, and this low shear rate is claimed to result in a lower torsional rate of the engine and transmission. Also, the angular position of the front mounts is said to increase the lateral stability of the engine because the mounts are in partial compression.

Transmission Moves . . .

. . . include two new automatic transmissions. In addition, established units have been revised to handle the increased loads of more powerful engines.

CHEVROLET's new triple-turbine "Turboglide" automatic transmission is claimed to produce nearly twice the torque multiplication delivered by "standard torque converters." Other innovations are that there is only one forward driving position on the quadrant, said to be made possible by the high torque multiplication characteristics, and the incorporation of a "hill-retarder" device. The hill retarder position is indicated by an HR on the control quadrant.

Basically, the new transmission consists of three turbines and two planetary gearsets, combined with a variable-pitch stator and the conventional torque converter pump, enclosed in a die-cast aluminum housing. Fig. 5 illustrates this transmission's operation phases. As the turning force of one of the turbines lessens, another takes over to maintain a constant positive drive.

In the hill retarder position, a turbulence is created in the oil in the converter to impart a drag on the rear wheels. This innovation is patterned after a similar device developed for Chevrolet's automatic truck transmission.

Coaxial distribution of torque loads is claimed to reduce wear. The Turboglide transmission is supplied only in conjunction with the 238-cu in. Chevrolet engine. (Complete details of this new transmission will be presented in a paper scheduled for presentation at the 1957 SAE Annual Meeting.)

Introduced on Imperial models during 1956 the "Torque-Flite" three-speed fully automatic transmission is extended to the complete line of 1957 Chrysler Corporation cars with certain modifications in design.

The Torque-Flite transmission (See Fig. 6) is a combination of a torque converter coupled to an automatically operating 3-speed planetary gear box, with pushbutton control, as distinguished from the Power-Flite transmission which is similar but has an automatic 2-speed planetary gear.

The torque converter, with its new ratios of 2.3, 2.6, or 2.7/1 (depending on the car application) is said to give improved starting and mid-speed performance and to permit a portion of its torque-multiplying ratio to be used at higher speeds (48–64 mph depending upon car application).

Improved performance is claimed by the selection of transmission gear ratios which give maximum acceleration in the various speed ranges. The low-speed ratio is 2.45/1 for fast starts and for reaching traffic speed quickly. Second-speed ratio is 1.45/1, offering a kickdown speed for added safety in highway passing, and provision for engine braking for hilly country.

To prevent the car from being started while in gear, the neutral button must be pushed in to shift the transmission to neutral. Then, pushing with an additional 3–5 lb effort compresses the operating slide spring actuating the starter switch. A vacuum switch is provided in the starting circuit as a safety feature to prevent operating the starter while the engine is running.

With the drive button depressed, the transmission always starts in

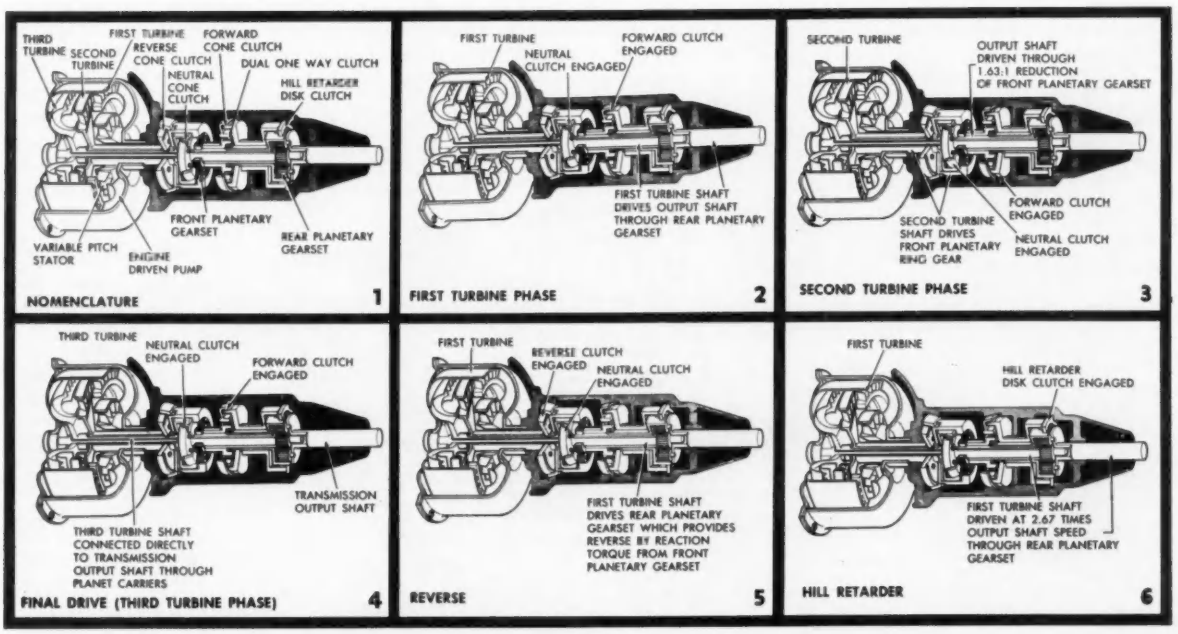

THIRD TURBINE
SECOND TURBINE
FIRST TURBINE
REVERSE CONE CLUTCH
FORWARD CONE CLUTCH
NEUTRAL CONE CLUTCH
DUAL ONE WAY CLUTCH
HILL RETARDER DISK CLUTCH
FRONT PLANETARY GEARSET
REAR PLANETARY GEARSET
VARIABLE PITCH STATOR
ENGINE DRIVEN PUMP
NOMENCLATURE 1
FIRST TURBINE
NEUTRAL CLUTCH ENGAGED
FORWARD CLUTCH ENGAGED
FIRST TURBINE SHAFT DRIVES OUTPUT SHAFT THROUGH REAR PLANETARY GEARSET
FIRST TURBINE PHASE 2
SECOND TURBINE
OUTPUT SHAFT DRIVEN THROUGH 1.63:1 REDUCTION OF FRONT PLANETARY GEARSET
FORWARD CLUTCH ENGAGED
SECOND TURBINE SHAFT DRIVES FRONT PLANETARY RING GEAR
NEUTRAL CLUTCH ENGAGED
SECOND TURBINE PHASE 3
THIRD TURBINE
NEUTRAL CLUTCH ENGAGED
FORWARD CLUTCH ENGAGED
TRANSMISSION OUTPUT SHAFT
THIRD TURBINE SHAFT CONNECTED DIRECTLY TO TRANSMISSION OUTPUT SHAFT THROUGH PLANET CARRIERS
FINAL DRIVE (THIRD TURBINE PHASE) 4
FIRST TURBINE
REVERSE CLUTCH ENGAGED
NEUTRAL CLUTCH ENGAGED
FIRST TURBINE SHAFT DRIVES REAR PLANETARY GEARSET WHICH PROVIDES REVERSE BY REACTION TORQUE FROM FRONT PLANETARY GEARSET
REVERSE 5
FIRST TURBINE
HILL RETARDER DISK CLUTCH ENGAGED
FIRST TURBINE SHAFT DRIVEN AT 2.67 TIMES OUTPUT SHAFT SPEED THROUGH REAR PLANETARY GEARSET
HILL RETARDER 6

Fig. 5—Operation phases of Chevrolet "Turboglide" triple-turbine automatic transmission.

low and automatically shifts to second, then to direct as the speed builds up. The car speed at which the automatic shift occurs is regulated by the throttle position and the load against which the engine is pulling. During highway passing below 70 mph, the transmission will automatically downshift to second when the accelerator pedal is fully depressed. Should the car be accelerated past 75 mph while in second, the transmission will automatically shift to direct—a safety feature which prevents damaging the engine by excessive speeds. Although any button may be depressed at any speed, the transmission will not shift into low gear until the car speed drops below 25 mph, nor will it shift into second gear unless the car speed is below 70 mph. Pushing the reverse button while the car is moving forward faster than 10 mph automatically shifts the transmission to neutral. (Complete details of this new transmission will be covered in a paper to be presented before the 1957 SAE Annual Meeting.)

To accommodate the lower bodies, Buick's twin-turbine Dynaflow automatic transmission has a shallower oil pan, new valve body, servo body, and a smaller starter ring gear located to the rear of the converter pump flange. Increase in engine power required another set of clutch plates making a total of six. In addition, the stator control valve has been revised so that the high stator blade angle will be obtained in "Drive" range only when the accelerator pedal is fully depressed. The converter pump is now of fabricated steel.

During the 1957 model year the dual-range Hydra-Matic transmission on the 1957 AMC Rambler will be replaced by an automatic transmission with a torque converter plus three forward and a reverse gear manufactured by Warner Gear Division of Borg-Warner Corp. This transmission is basically the same as the Ford "Fordomatic" or the Studebaker "Flightomatic."

A new, smaller diameter 12-in. steel torque converter replaces the former one used on Lincoln and Lincoln Continental. Replacing the integral forced air cooling system used in previous converters, a new external transmission cooler consists of a radiator located ahead of the standard radiator, to provide for cooling of the transmission fluid. Pressure-feed and return oil lines connect the auxiliary radiator to the torque converter.

The 1957 Mercury features "Keyboard" pushbutton automatic transmission control. A combined neutral/start button takes the car out of any previous gear position and starts the motor. A safety electrical sensing device prevents engagement of the reverse gears even if the reverse button is pushed accidently above 10 mph. The emergency brake is released by depressing a bar.

In addition, many manually operated transmissions have been strengthened to handle the increased power and made easier and quieter to operate. For example, Oldsmobile has done it by adding ribbing to the case; enlarging the main shaft; increasing the capacity of the rear bearing; widening the clutch gear, counter gear, and second-speed gears; adding a new counter gear thrust bearing; and strengthening the second and third shifter fork. Gear ratios have been lowered as follows: first to 2.15/1 from 2.39/1; second, to 1.37/1 from 1.52/1; reverse, 2.28/1 from 2.53/1.

Ford is using finer pitch gears with slightly greater helix angles and reduced pressure angles. Countershaft sliding and idler gears will be made from nickel-chrome-molybdenum alloy in place of chromium steel. Ratios have been revised to suit the new tires, engines, and axles.

On its cars equipped with manual transmission, Pontiac offers a 10.5-in. clutch employing 12 coil springs replacing the 10-in. diaphragm type used in 1956.

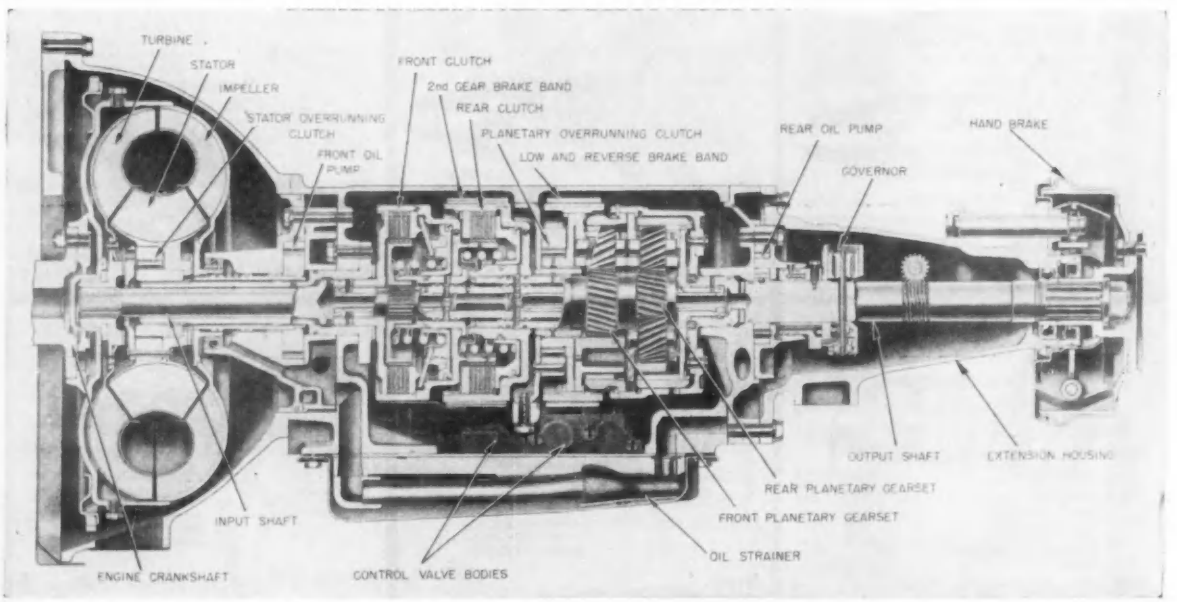


Fig. 6—Chrysler Corp.'s "Torque-Flite" automatic three-speed transmission.

Drive Lines and Rear Axles . . .

. . . have been changed to lower bodies and to handle increased engine power and the smaller 14-in. wheels, rims, and tires.

THESE changes include increased drive pinion offsets; two-piece, three-joint propeller shafts; adjusted rear axle ratios; and higher capacity gears, bearings, universal joints, and housings. In addition, two makers have come out with "limited-slip" differentials.

Offset Drive Pinion

For example, the 1957 Ford rear axle features greater offset and more rigid mounting of the drive pinion. The redesigned drive pinion is now offset 2.75 in. below the centerline of the axle as compared with 1.5 in. last year. This change, in combination with either the optional tapered or stepped driveshaft, permits a smaller tunnel and contributes to lower car heights. The redesigned axle carrier, in addition to accommodating the greater offset of the pinion, has been strengthened through the use of intersecting semi-circular ribs. To handle the greater torque output of the new, more powerful engines, universal joints of 39% greater capacity are used. A new arrangement of bearings permits the pinion head to be mounted with roller bearing directly fore and aft. This straddle mounting is said to permit better life and quieter operation.

To permit lowering of the body, the Cadillac and Oldsmobile propeller shaft is of 2-piece, 3-universal-joint construction with the center joint mounted in rubber. Buick's torque tube has been slanted downward from its former horizontal position; and the depressed torque tube made necessary the introduction of a second universal joint at the rear end of the propeller shaft. The universal joint assembly includes a yoke connecting the joint to the universal.

Load-carrying capacity of Cadillac and Oldsmobile differentials has been increased 25% by use of a larger diameter ring gear and drive pinion gear; by higher capacity rear pinion bearings; and by a larger axle housing. To accommodate its narrower rear tread of 61 in., Cadillac has a new rear axle and rear-axle housing. The new 3.07/1 ratio gearset has a 50-deg helix as compared with 45 deg in 1956.

"Limited-slip" differentials are offered as optional equipment on Studebaker V-8 models and on the Lincoln and Lincoln Continental lines. This differential allows the axle to transmit the major driving force to the wheel having the better traction. It is said to divide the engine power automatically between the rear wheels in the proportions necessary to stop wheel slipping and spinning under adverse driving conditions, such as mud, snow, sand, and ice. Up to 80% of the engine power driving force is claimed to be transmitted to the rear wheel with the best traction.

Cooling Efficiency Up . . .

. . . through larger radiator areas, higher pressures, faster coolant flow rates, and automatic cooling fans.

IMPROVEMENTS in the Ford line are increased radiator core area; more efficient, smaller fan; and a faster rate of coolant flow. The radiator has been lowered 2.2 in., of which 1.6 in. has been in the upper and lower tanks and only 0.6 in. in the core. To overcome this reduction in height, the width has been substantially increased. Consequently, there has been no loss in tank capacity and the addition of 10 rows of water passages allows a greater flow of coolant. The frontal area has been enlarged by 6% to 369 sq in. on all 6-cyl models and by 25% to 434 sq in. on the 8-cyl models. Because the radiator core is shorter and is repositioned with respect to the engine, a smaller diameter fan can be used and still provide equivalent cooling. This is made possible by the fan sweeping more of the upper portion of the radiator where temperatures are highest.

Pontiac has raised the pressure of its cooling system to 13 psi from 7 psi used in 1956, permitting the coolant to operate at 11 F higher before boiling. Pontiac's tube-and-center radiators have been strengthened structurally to withstand the higher pressure.

The 1957 Mercury and Lincoln lines feature an automatic cooling fan which uses a thermostatically-controlled clutch using silicone fluid to govern the speed of the fan. The thermostatic control element is installed in the engine water pump impeller. Whenever the engine is at normal operating temperature or below, the fan idles on its shaft. When increasing water temperatures actuate the thermostat, a pushrod engages the fan drive to provide the needed cooling air. Savings of up to 17 hp are claimed for the device.

Lubrication Aims . . .

. . . are simpler and better lubrication for the 1957 models.

LUBRICATION of the front suspension and the steering system of all Chrysler Corp. lines has been reduced to 8 points—four tie-rod ends and four ball joints. In the past, lubrication of from 21 to 23 points was required.

Full pressure lubrication to the valve lifter galleries replaces the former metered system on all Chevrolet V-8 engines.

A vacuum booster has been added to the under side of Buick's oil pump; a ball-type relief valve replaces the piston type; thickness of the oil-pump gears has been re-

duced to 0.875 in. from 1.25 in., and their number of teeth has been decreased from 14 to 8. The latter changes lowered the overall height enough to make room for the inverted vacuum pump.

A full-flow, throw-away type oil filter is introduced on all lines of Ford Motor Co. The possibility of oil spillage is said to be virtually eliminated by the inclusion of a spring-loaded valve inside the filter housing which prevents oil leakage or dripping once the oil filter is unscrewed.

Exhaust Changes . . .

. . . aim to improve performance, reduce noise, and to accommodate redesign throughout the new cars.

FORD's new mufflers have been relocated on the chassis, and tailpipe configurations have been altered to increase body footwell space within the frame. All 8-cyl engines except the 312 cu in. power option will feature, as standard equipment, a "Y" pipe with extensions running from each bank of cylinders into a single muffler and tail pipe located along the left-hand side of the frame. Triple-wrapped mufflers used with the 8-cyl engines are of a new size to fit more conveniently into the new chassis. The major diameter of the oval section remains unchanged at 7.75 in.; the minor diameter, however, has been increased by 0.75 in. to 4 in. and the length reduced from 31 to 24 in. This change in size has been accompanied by revised tubes and baffles within the muffler. The Thunderbird Special 312 cu in. engine option includes a dual exhaust system with resonators.

Pontiac's new muffler has an increased cross-section and a side inlet and side outlet replacing the side inlet and center outlet design. It is claimed to reduce back pressure and produce better tuning. Pontiac's dual exhaust system is provided with dual resonators and discharges through the rear bumpers, except on station wagons where tail pipes exhaust below the bumpers.

Mufflers used in Buick's single and dual exhaust systems are of reverse-flow type, of two-piece construction. Tailpipes are 2 in. in OD and are made from aluminum-coated steel.

On Oldsmobile dual exhaust system, resonators have been added in each tail pipe, and the muffler of the single exhaust system is 15% larger.

Chevrolet's new exhaust manifolds for its V-8 engines provide larger passages which gradually increase in cross-sectional area from the inlet port at the cylinder head to the outlet.

Fuel Injection . . .

. . . introduced by Chevrolet and the supercharger featured on Studebaker are the innovations in fuel systems. The fuel injection system is a first in American production cars, and the supercharger is the first used in American cars since the Thirties.

CHEVROLET's continuous-flow "Ramjet" fuel injection system (Figs. 7 and 8) has made it possible for the first time in American passenger cars to reach an output of 1 hp per cu in. of displacement. It supplies a precisely controlled air and fuel mixture to each cylinder of the engine. Claimed advantages are faster response to the accelerator and a resulting sense of greater smoothness, both during engine warmup and under normal operating conditions.

Starting is said to be quick and positive, even in severe weather, and smoother idling and low speed operation, together with greater overall fuel economy, is claimed. The system supplies fuel under pressure right up to the cylinder head intake ports through individual fuel lines. Separate passages are also provided to supply clean air all the way to each individual cylinder head intake port. Here the fuel, finely atomized by the injection nozzles, mixes thoroughly with the fast-moving air and is drawn into each combustion chamber, thus providing precise and uniform cylinder-to-cylinder distribution.

Because fuel is vaporized at the cylinder-head intake ports, and the incoming air does not pass through a venturi of the carburetor type where refrigerating action takes place, the induction system does not require heat to prevent icing or to help atomize the fuel. As a result, the incoming air is not subjected to external heat and a larger quantity of air is drawn into the combustion chamber. Volumetric efficiency is thus improved and engine power increased.

In operation, the accelerator controls the volume of air admitted to the engine. A mechanism of the fuel injection system continuously measures the volume of incoming air and automatically meters the precise quantity of fuel to be mixed with the air. Other mechanisms enrich the mixture for acceleration, hill climbing and warmup, and also insure instantaneous delivery of fuel to the nozzles for starting, provide for smooth engine idling, and cut-off fuel when coasting downhill.

The system includes specially designed components, such as an air metering system, fuel metering

system, and fuel nozzles. The one-piece cast iron intake manifold and engine cover used on carburetor model Chevrolet engines is replaced by two separate aluminum castings. (See Fig. 7.) The lower casting forms the top cover of the engine, while the upper contains the air passages and mounting for the air metering and fuel metering systems. Other new components include an auxiliary fuel filter, a special ignition distributor which drives a high pressure fuel pump through a flexible drive, and a new electric choking system for cold starting.

Air Intake

Outside air for the engine is routed through an air cleaner, and then passes into an air meter, the intake manifold, cylinder head, and combustion chamber. (See Fig. 9.) The entrance to the air meter is through a venturi or narrow passage. This passage also has a small opening leading to a vacuum tube. As the outside air rushes into the engine through the venturi, it tends to draw the air out of the tube, which creates a vacuum in the tube. The degree of vacuum is an accurate measure of the volume of air being drawn into the engine.

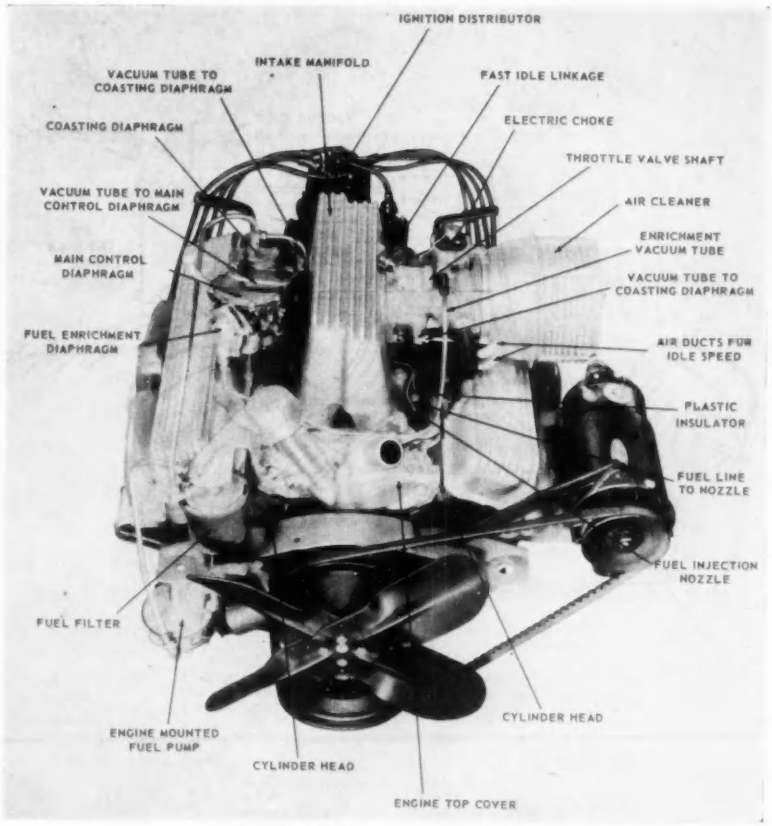


Fig. 7—Chevrolet V-8 with "Ramjet" fuel injection.

Fuel Intake

A fuel meter is used to supply and regulate fuel to the engine. (See Fig. 10.) The regular engine fuel pump sends fuel through a fine filter and into a reservoir in the fuel meter housing. The quantity of fuel in the reservoir is maintained at a fixed level by a float-controlled valve. Another fuel pump, submerged in the reservoir fuel, is driven by the ignition distributor through a flexible cable. Fuel under high pressure from this pump passes into a central passage where it must lift a ball check before flowing through a series of small holes into a metering chamber. At this point the fuel can go either to the injection nozzles at the intake ports, or back to the reservoir, depending upon the position of a plunger.

Pressures at the 0.011-in. orifices of the nozzles measure up to 200 psi. When the plunger is raised, fuel flows back to the reservoir. As the plunger is lowered, a portion of the fuel flows to the injection nozzles and the remainder returns to the reservoir. The ball

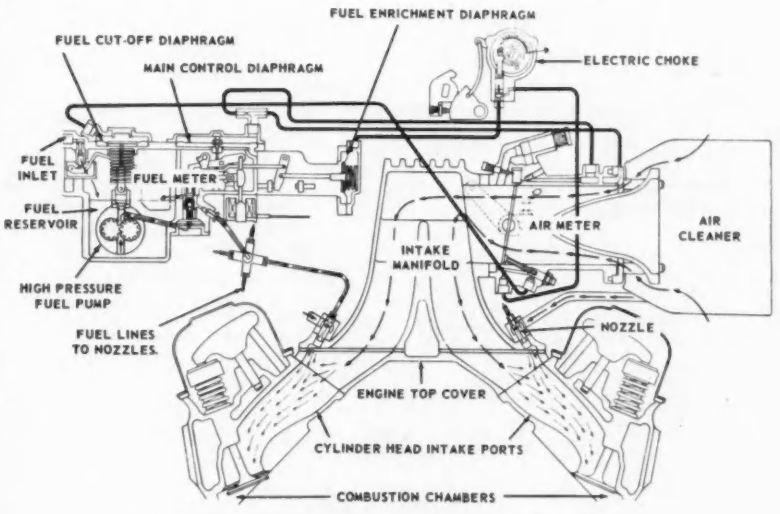


Fig. 8—Schematic layout—Chevrolet fuel injection system.

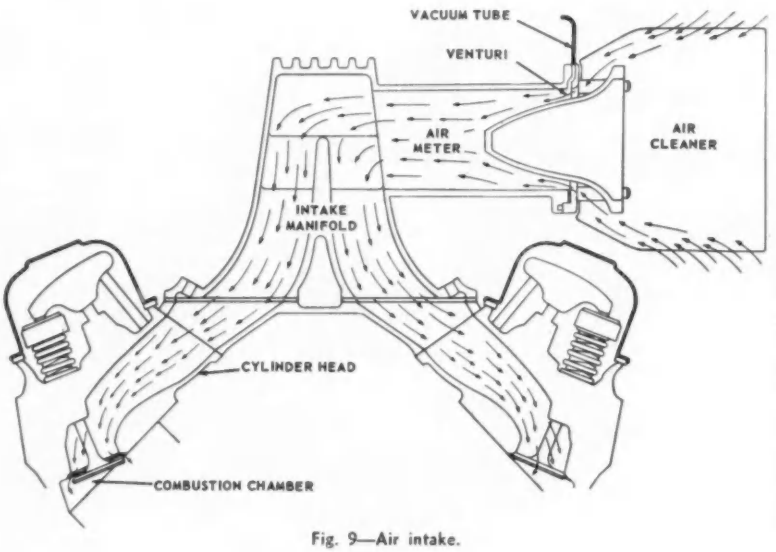


Fig. 9—Air intake.

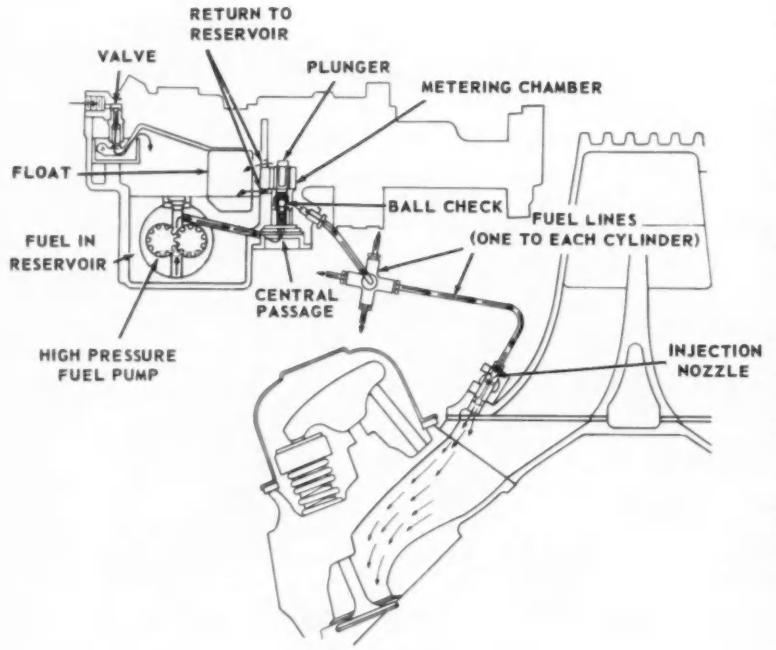


Fig. 10—Fuel intake.

check in the central passage permits fuel to flow from the pump when fuel pressure is about 15 psi or higher so that any vapors which may have formed are compressed back into a liquid.

Accurate Fuel Delivery

As the incoming air passes through the venturi and is measured, it sends a vacuum signal to a main control diaphragm in the fuel meter. (See Fig. 11.) Depending upon the amount of vacuum, the diaphragm meters fuel by raising or lowering the plunger through a lever, thus delivering with high accuracy the precise quantity of fuel required by the engine for the volume of air being used.

All levers in the fuel metering system are counterbalanced so that their movements are unaffected by their own weight. Lever positions are determined only by forces exerted by the sensing devices.

The intake manifold has eight individual passages, called ram pipes, one for each cylinder. (See Fig. 12.) The fuel injection nozzles are mounted in plastic insulators in the lower part of the intake manifold, near the cylinder head intake ports. As the inlet valves open, fuel spray from the nozzles, which has mixed with the onrushing air, enters the combustion chamber where it is compressed and ignited in the same manner as in a conventional carburetor system. A throttle valve, controlled by the driver through the accelerator, determines the quantity of air, and as previously explained, the quantity of fuel supplied to the engine.

So that the amount of fuel injected is determined solely by the fuel metering system, and not influenced by variations in vacuum, the nozzles are designed to inject fuel into atmospheric pressure at all times. This is accomplished by supplying air from the air cleaner to a small chamber in each nozzle. The fuel injected from a small orifice passes through this chamber, and out a small opening to the intake port.

The arrangement has the added advantage of assuring a consistently accurate fuel/air ratio for idling the engine. The volume of air passing through the chamber, although smaller when compared with the volume flowing through the intake manifold in normal

driving, constitutes a major share of the air used by the engine during closed throttle or idling conditions.

Fast Acceleration

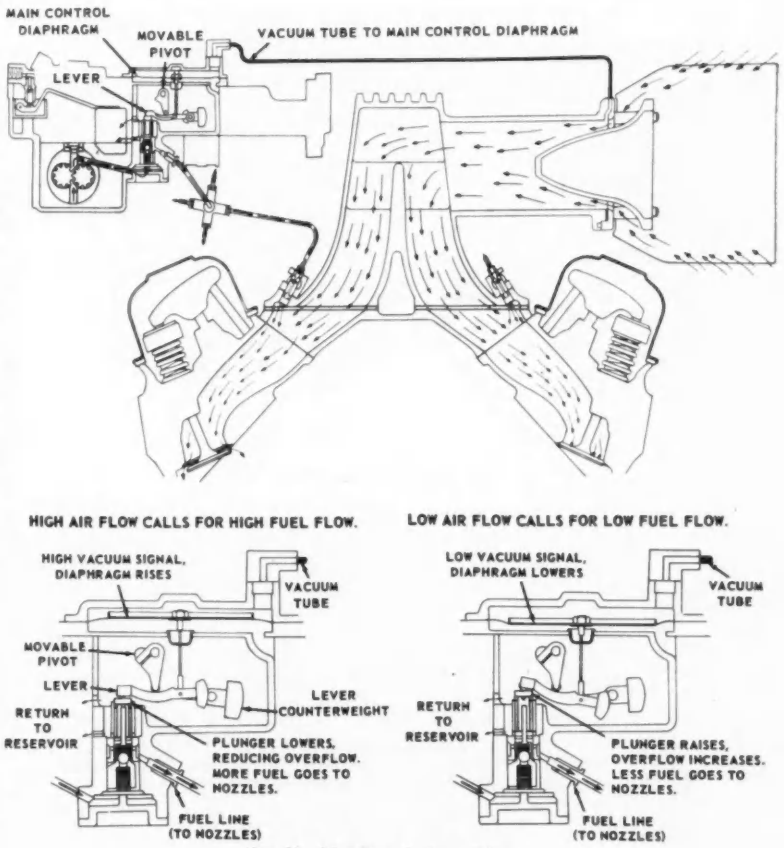
The movable pivot in the fuel metering system is connected by a rod to a fuel enrichment diaphragm, and is normally held in a position which provides maximum economy of operation. (See Fig. 13.) The enrichment diaphragm is controlled by vacuum created when air rushes past the opening at the throttle valve. When the throttle valve is partially opened, air rushes through the small space of the opening on its way to the engine, and tries to draw air out of the enrichment vacuum tube. The resulting vacuum in the tube is strong enough to hold the diaphragm back against the opposing force of a spring. This holds the movable pivot in the fuel economy position.

When fast acceleration or more power is called for, the driver presses on the accelerator which opens the throttle valve wider. The incoming air now has a larger opening to pass through, and therefore draws less on the enrichment vacuum tube, reducing the vacuum. The spring now overcomes the reduced vacuum force and moves the diaphragm out. As a result, the movable pivot is pushed toward the end of the lever, moving the plunger down. Therefore, fuel return to the reservoir is reduced and fuel flow to the injection nozzles increased. The richer mixture gives increased power for fast acceleration.

Easy Cold Starting

For fast engine starting, it is necessary to get fuel to the nozzles quickly when the starting motor is turned on. (See Fig. 14.) Since it would take from 20 to 30 sec at cranking speed for the fuel pump to build up enough pressure to unseat the ball check, a solenoid is used to open a direct fuel passage to the nozzles.

When the starting motor is engaged, the solenoid, which is automatically energized at the same time, forces a solenoid link upward. This, in turn, pushes the starting lever which forces the plunger down, unseating the ball check. Fuel then is routed directly from the fuel pump to the nozzles. The solenoid is de-ener-


MAIN CONTROL DIAPHRAGM
MOVABLE PIVOT
VACUUM TUBE TO MAIN CONTROL DIAPHRAGM
LEVER
HIGH AIR FLOW CALLS FOR HIGH FUEL FLOW.
HIGH VACUUM SIGNAL, DIAPHRAGM RISES
VACUUM TUBE
MOVABLE PIVOT
LEVER
LEVER COUNTERWEIGHT
RETURN TO RESERVOIR
PLUNGER LOWERS, REDUCING OVERFLOW. MORE FUEL GOES TO NOZZLES.
FUEL LINE (TO NOZZLES)
LOW AIR FLOW CALLS FOR LOW FUEL FLOW.
LOW VACUUM SIGNAL, DIAPHRAGM LOWERS
VACUUM TUBE
RETURN TO RESERVOIR
PLUNGER RAISES, OVERFLOW INCREASES. LESS FUEL GOES TO NOZZLES.
FUEL LINE (TO NOZZLES)
Fig. 11—Matching fuel to airflow.

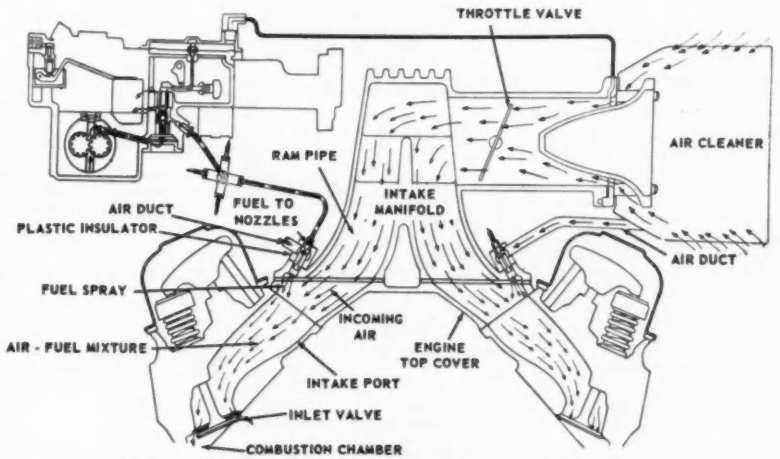


Fig. 12—Fuel mixes with air and is drawn into the combustion chamber.

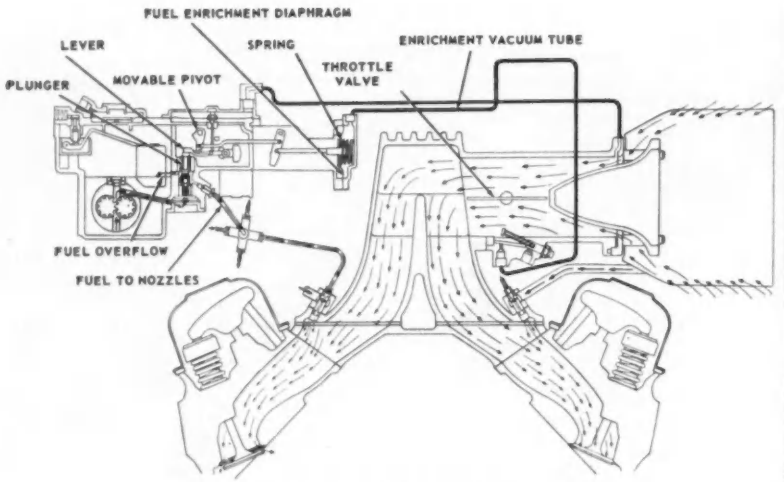
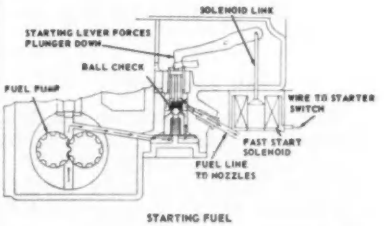
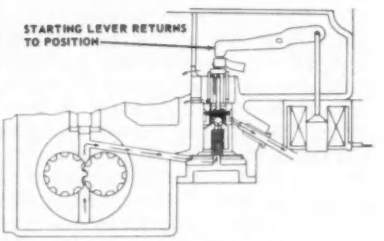


Fig. 13—Fast acceleration.

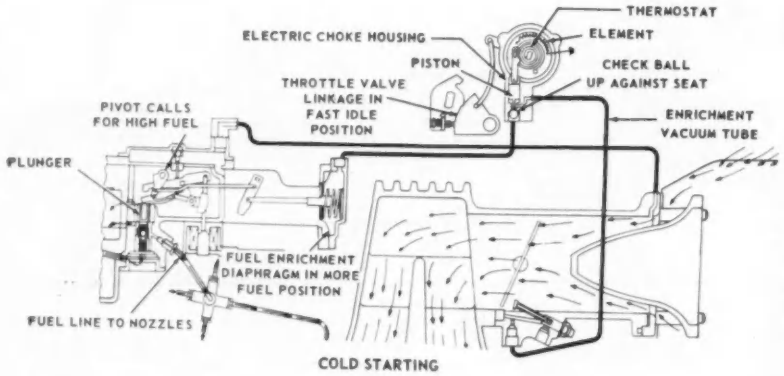


STARTING FUEL

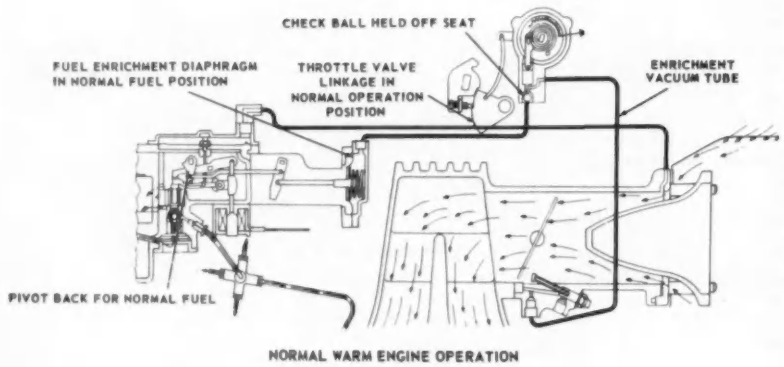


RETURN TO NORMAL

Fig. 14—Cold starting.



COLD STARTING


CHECK BALL HELD OFF SEAT
FUEL ENRICHMENT DIAPHRAGM IN NORMAL FUEL POSITION
THROTTLE VALVE LINKAGE IN NORMAL OPERATION POSITION
ENRICHMENT VACUUM TUBE
PIVOT BACK FOR NORMAL FUEL

NORMAL WARM ENGINE OPERATION

Fig. 15—Engine warmup.

gized when the driver releases the key-turn starting switch.

Engine Warmup

After starting and during warmup, it is desirable to furnish slightly richer fuel mixtures than would normally be supplied. (See Fig. 15.) This is accomplished by changing the position of the pivot in the fuel metering system to call for more fuel. The fuel enrichment system and an electric choke are used for this purpose. The enrichment vacuum route from the air meter to the fuel enrichment diaphragm passes through the electric choke housing. On cold starts, vacuum in the housing pulls a check ball upward against a seat, cutting off the vacuum to the enrichment diaphragm. As a result, the spring moves the pivot toward the end of the lever, moving the plunger down, routing fuel to the nozzles. In the choke housing the vacuum is then applied to the bottom of a piston. At the top end, the piston is linked to a thermostat heated by an element which carries electric current whenever the ignition switch is on. As the thermostat is heated, it relaxes and allows vacuum to pull the piston downward. In its lowest position the piston pushes the check ball off its seat, returning

the fuel enrichment system to normal operation.

The electric choke also controls linkage which holds the throttle valve slightly open for fast engine idling after cold starts. As the thermostat heats up, the linkage and engine idle speed return to their normal settings.

Fuel Cut-Off for Coasting

When coasting downhill or decelerating from higher engine speeds, an automatic fuel cut-off system stops fuel waste and discharge of exhaust fumes. (See Fig. 16.)

When going downhill with the foot off the accelerator, the throttle valve is closed, but the engine, being pushed by the vehicle, tries to pull in large quantities of air. This creates an unusually high vacuum at the closed throttle valve. This vacuum is used to send a signal, through a tube, to a diaphragm located above the high-pressure fuel pump. The high vacuum raises the diaphragm and a connecting link opens a valve over the fuel pump, and discharges the fuel directly back to the fuel reservoir. As a result, all of the fuel from the pump is discharged in the fuel reservoir, none going to the injection nozzles or engine. The high vacuum diminishes as the vehicle slows down, closing the valve over the fuel pump, and fuel again flows to the nozzles. The transition from coasting fuel cut-off to normal operation is said to be so smooth that the driver and passengers are not aware of the change. (Additional details of the system will be presented in a paper scheduled for presentation at the SAE 1957 Annual Meeting.)

New Supercharger

Studebaker's "Jet Stream" supercharger (furnished by McCulloch Motors Corp.) has helped to lift the output of Studebaker's 289 cu in. V-8 engine that powers the "Golden Hawk" to 275 hp. (See Fig. 17.) The supercharger provides a full pressure system that operates on an optimum pressure of 5 psi, and rams about 30% more fuel and air mixture into the combustion chamber. The unit, shown in Fig. 17, is driven at speeds up to ten times engine speed through a variable-rate pulley arranged to produce maximum power during acceleration while permitting nor-

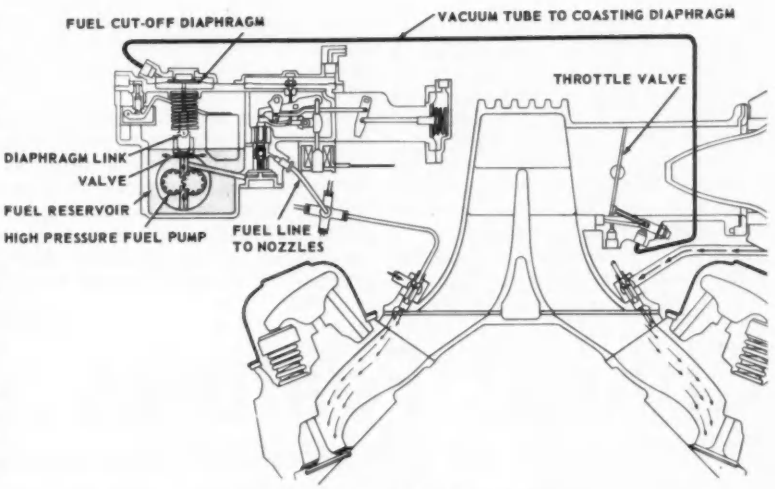


Fig. 16—Fuel is cut off when coasting.

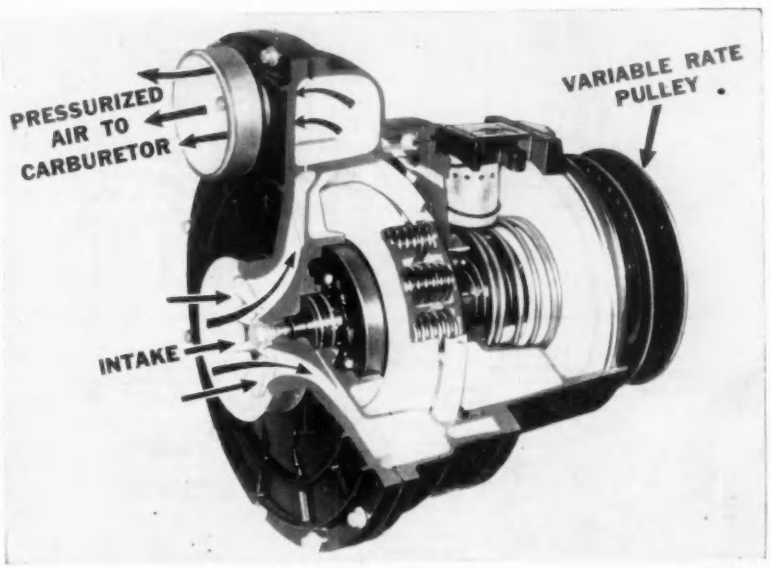


Fig. 17—Studebaker "Jet Stream" supercharger.

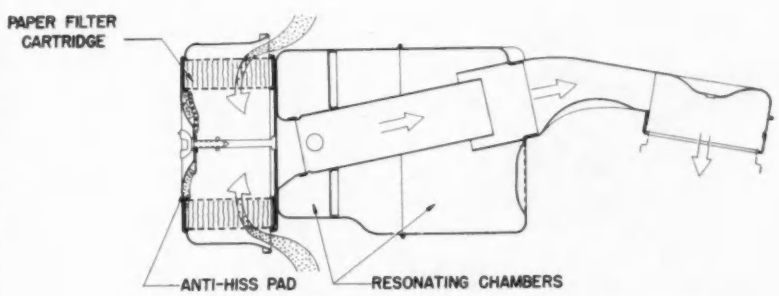


Fig. 18—Chrysler Corp.'s carburetor air cleaner and silencer.

mal fuel economy at cruising speeds.

New Filters

Almost universally employed to permit lowering hoods by several inches and to meet the increased air requirements of more powerful engines are new squat-design air filters. Because it meets these requirements well, the pleated-paper replaceable type of dry air cleaner is introduced for the first time in all 1957 models of the Chrysler Corp. and Ford Motor Co. Its claimed advantages are three: it adapts itself better than other types to the vertical space restrictions necessary to lower hoods; it is more efficient at low engine airflow; and lower cost.

The paper used in these filters is pleated to interpose a large area of paper to the airflow in a restricted space. The paper is resin-impregnated and is heat-cured after pleating. It is also treated chemically with silicone compounds to provide water repellency. When clogged, the replaceable pleated-paper unit be restored to almost its original capacity, by removing it and rapping it on a hard surface.

Fuel Pump Change

Buick's fuel pump has been inverted to reduce tendency to vapor lock. (See Fig. 18.) Fuel now enters at the bottom, and is fed by a diaphragm-type pump through the supply line to the carburetor under pressure of 5¼ to 6½ psi.

Chassis Features . . .

. . . include torsion bar front suspension, rubber bumper rear suspensions, unorthodox frames, improved brakes, 14-in. wheels and tires, and safer and easier steering.

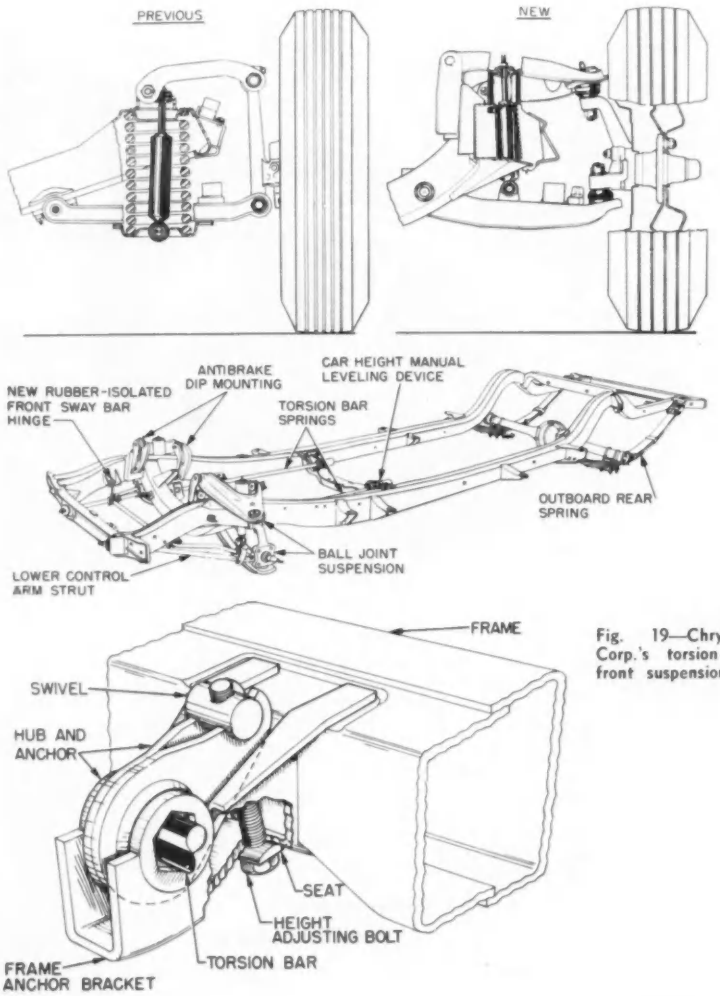


Fig. 19—Chrysler Corp.'s torsion-bar front suspension.

CHRYSLER Corp.'s new torsion-bar front suspension features new developments which include extended application of ball joints, "anti-dive" devices, variable-rate coil springs, and shock-absorber refinements.

Torsion bar springs (see Fig. 19) have been adopted in the front suspension system of all Chrysler Corp. lines. These springs are preloaded to prolong their fatigue life.

The change to torsion-bar springs saved space. They required less of the engine compartment space. The removal of coil springs also reduced engine compartment height requirements, allowing the car silhouette to be lowered.

Ball joints (see Fig. 20) also feature the front suspensions of all Chrysler Corp. cars. The ball-joint pivots are farther apart than kingpin bearings, increasing the lever arm of resistance to lateral road forces against the front wheels. This is claimed to reduce unwanted wheel motions and to give a more stable feeling to the front end.

The upper ball joints do not carry any car weight, as do the lower ball joints; hence they are preloaded enough to keep the joint together. However, neither the upper nor lower ball joints are further preloaded to counteract the phenomenon of wheel "flutter" as was necessary with the previous kingpin bearings. Therefore, the resistance to turning is much lower, reducing steering effort and

improving returnability of the front wheels.

In an effort to reduce the car dip associated with braking, the upper control arm inner pivots were located on the frame such that the lifting component of forces originating from braking counteracted a proportion of the forward weight shift. It is said that this design reduces car dip by 65%.

To minimize harshness originating from vertical movement of the front wheels, a front sway bar is attached to the frame with a flexible hanging hinge on all Imperials, Chryslers, and DeSotos, and on some Dodges. As the front wheels move up and down over bumps and holes, the effective length of the sway bar lever arm varies according to the amount of vertical movement of the wheels. These variations are automatically compensated for by the flexibility of the hinge.

Reduced front end harshness and less road noise transmitted to the car are objectives of isolating Chrysler Corp.'s steering and suspension system in rubber. The inner pivot points of the upper control arm and the forward end of the torsion bar to which the lower control arm is attached are isolated from the frame by rubber bushings. Also, the rubber mounting of the lower control arm strut permits a slight fore-and-aft movement of the front wheels, absorbing some of the harshness. This helps reduce road shock due to bumps and chuckholes.

The steering linkage is also isolated from the frame by rubber. The idler arm pivot is rubber bushed, so that movement of the arm puts the rubber in torsion. The center link pivots at the steering gear arm and idler arm have rubber and nylon bushings, the rubber insulator absorbing road shock and noise while the nylon bushing reduces friction.

Ball-joint pivots and anti-dive geometry are new in Buick, Cadillac, and Oldsmobile's front suspensions. (See Fig. 21.) The upper ball joint consists of a spring-loaded ball stud in a forged housing with the ball seated on a layer of phenolic material bonded to the forging. The lower ball joint is the compression-type design with the ball of the stud held into a phenolic material seat in a forged housing by the weight of the car. Caster and camber are adjusted by shimming between the upper control arm shaft and the frame bracket. To give better cornering stability with the new suspension, Cadillac's front tread has been increased to 61 in.

Ball-joint pivots are claimed to provide a 60% correction on dive. The system is arranged so that the path of movement of the arms relative to one another is such that reaction forces during braking oppose forward pitch or dive. In short, the force causing the dive is neutralized by lever action from the brakes themselves. The wheel spindle and steering knuckle are part of an integral alloy forging attached directly to the suspension arms by means of ball joints located at the outer ends of both upper and lower steering arms.

Oldsmobile's spring base has been widened 2 in. for greater stability on curves; larger wheel bearings give 40% greater load-carrying capacity.

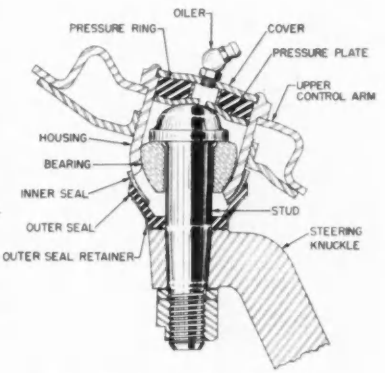
To provide a softer ride, Pontiac's front spring rate has been lowered and shock-absorbing valving has been modified.

Studebaker introduces variable-rate coil springs in its front suspensions. (See Fig. 22.) They are said to provide stiff springing for rough road surfaces and softer springing for boulevard riding. The principle is that individual coils compress one by one at an unequal rate, rather than at the same rate. The purpose is to give the same degree of soft ride with one to five passengers as is obtained by conventional springs with a heavy load.

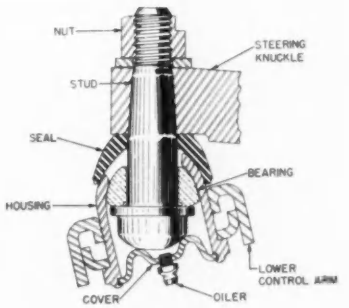
The Mercury front spring pocket has been enlarged to house a new longer coil spring resulting in a softer ride. Constant softness (ride frequency) has been improved by means of auxiliary rubber springs. A swept-back front suspension design is featured on both Ford and Mercury which produces, in effect, a trailing arm suspension by which the front wheels are pulled over bumps instead of pushed into them. In addition, special rubber bushings located at the anchor of the control arm further cushion the impact of road vibrations for the front car structure.

A redesign of the Ford front suspension unit for 1957 results in 33% fewer parts than used previously. Ball-joint sockets are of stamped steel rather than the forged type used in the past.

Both upper and lower control



FRONT SUSPENSION UPPER BALL JOINT



FRONT SUSPENSION LOWER BALL JOINT

Fig. 20—Chrysler Corp.'s front suspension ball joints.

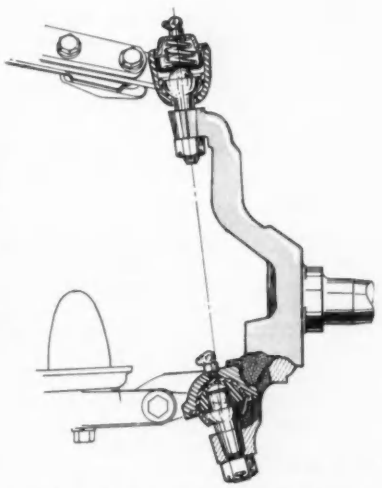


Fig. 21—Ball joints and knuckle—Buick front suspension.

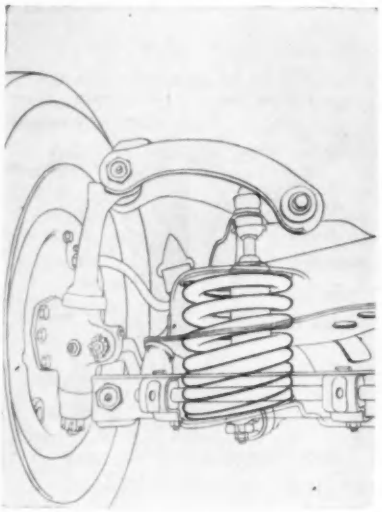


Fig. 22—Studebaker variable-rate front coil spring.

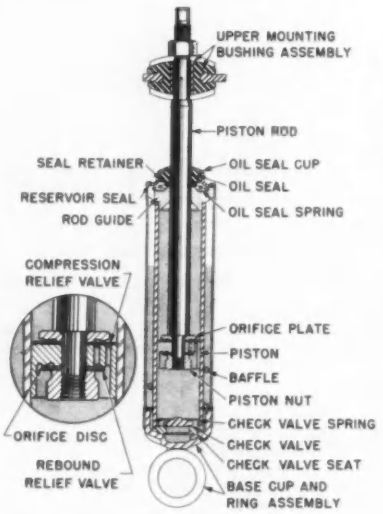


Fig. 23—Front shock absorber—Chrysler Corp. front suspension.

arms are of a one-piece stamped steel construction. This reduces the weight approximately 10%. The lower control arm has been swept back 20 deg to approach, in effect, a trailing arm type of suspension.

This swept-back trailing arm type of suspension permits the use of a new linkless type of front stabilizer. Mounted to the lower control arms, this bar, by means of the torsion principle, assists in maintaining front end stability.

The integral spindle and spindle support made possible by ball-joint front suspension has been further improved to incorporate the steering arm, thus providing a rigid one-piece structure and reducing the total number of front suspension parts.

The valving of the front "Oriflow" shock absorbers has been revised in the 1957 Chrysler Corp. cars to give more control to spring movement due to minor road surface variations. (See Fig. 23.) Additional flexible discs are inserted in the flow path of fluid through the shock absorber piston, giving additional control over fluid flow, especially at low piston speeds. This gives control to suspension motions originating from very slight road imperfections.

In the 1957 Mercury shock absorber, in the up as well as down movement of the wheels, there has been added a special control which takes over when the relief or blow-off valve is open. This control is a restricted orifice which has no action at low car speeds or on small road irregularities but acts like a hydraulic cushion at very high car speeds or at all speeds over repeated bumps.

Lincoln has added new shock absorbers to its ball-joint front suspension system. Utilizing an hydraulic "rebound cut-off" feature, the shock absorber is designed to stop the front wheels from snapping all the way down when they come in contact with chuckholes and uneven road surfaces.

Rear Suspension . . .

. . . features new to 1957 cars include rubber bumpers and what is claimed to be the first air-cushioned rear suspension. Aimed at is a softer, more comfortable ride under all driving conditions.

THE 1957 Mercury features an air cushion at the front end of the rear springs. (See Fig. 24.) This cushion is claimed to reduce the cyclic vibratory effect of the axle forces transmitted to the body in the lateral, longitudinal, and vertical direction. It does this by softening the frame attachment of the rear spring front eye in all three directions of motion.

Driving and braking forces are air cushioned by the soft front eye spring-to-frame attachment.

The air cushion attachment between the frame and the spring eye is said to roll almost like another tire in its absorbing action and does so without affecting the handling characteristics of the car.

Atmospheric pressure is used in these tire-shaped insulators, thereby eliminating the complication of a compressor or inflator.

In station wagon models an additional rubber spring is located on the top of the rear axle and inside the frame side rail. This compensates for the greater variation of rear load experienced with the station wagon.

To achieve improved ride control under poor road conditions, a number of design innovations have been incorporated in the Ford rear suspension, including five rubber bumpers, to result in a level keel variable-rate suspension. (See Fig. 25.)

The new semi-elliptic rear springs are longer overall and have four leaves instead of five as used in 1956. To offset the tendency of the car to squat on fast acceleration or to nose-dive on fast stops, the front sections of the number two, three, and four leaves have been lengthened from 1 to 3½ in., causing the front of the spring to be stiffer than the rear. This results in a torque arm effect and is said to give up to 45% less rear end squat on fast starts and up to 20% less nose dive angle on fast stops.

The new springs are mounted on outboard hangers to give a broader base of support and to cradle the new lower frame.

As the spring load increases, the bumpers midway between the spring hangers and the axle limit the deflection of the forward portion of the spring, thereby reducing their effective length and stiffening the spring action. The tention shackles also stiffen the

spring by placing it under greater compression. These changes in spring rate vary with the load.

An important ride improvement with the new suspension is the new progressive absorption of strike-through or bottoming. A rubber nose bumper has been added to the number four cross-member of the frame which contacts a nose shield on the pinion carrier of the rear axle. In the case of a severe bump, the nose bumper strikes first, depressing the nose, causing a twisting or rotation of the axle housing against the springs prior to the axle bumpers contacting the axle housing which is the final stage of the strike through. These actions being progressive greatly reduce the harshness of strike through. Station wagons, having stiffer springs, do not use a nose bumper.

Rubber bushings are used in both front and rear spring eyes plus thick rubber pads between the axle housing spring seats and springs. Rubber is used to insulate against road noises being transferred to the body.

Replacing the parabolic section springs used heretofore, Pontiac rear spring leaves include a rectangular section main leaf and bottom plate as well as intermediate leaves that are grooved to facilitate liner retention. The main leaf of the 60-in. springs used on the 28 series will be shotpeened, and the 58-in. springs on the 27 series will employ six leaves instead of five. Full-length butyl rubber liners introduced on 1956 passenger cars will be employed in 1957 Pontiac station wagons for the first time. Spring rate has been lowered and shock absorber valving modified to produce a softer ride on all cars.

Cadillac's rear semi-elliptic springs have been moved outboard, closer to the wheels, and the rear tread has been decreased 2 in. to 61 in., the same as the front tread.

Oldsmobile's rear shock absorbers has been moved outboard to a position outside of the springs to reduce roll on curves.

Rear springs of Chrysler Corp.'s 1957 cars are attached outboard of the frame, lengthening the support of the frame and body on the rear axle. The rear axle has been clamped closer to the front of the spring, and most of the leaves are combined in this forward section, giving a short, stiff spring section of very high rate.

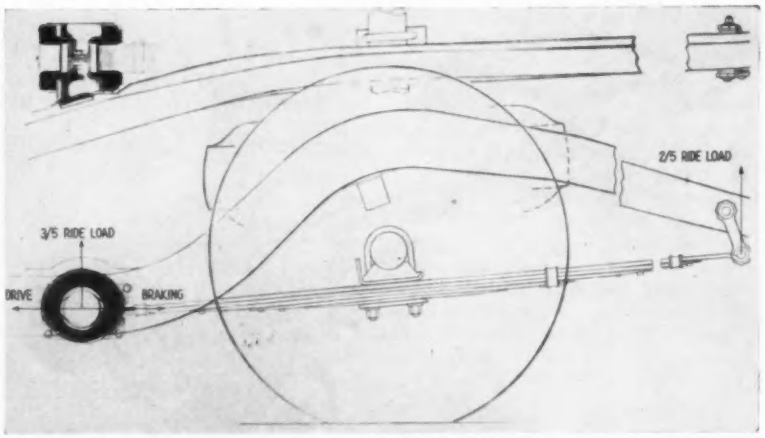


Fig. 24—Mercury's rear suspension features an air cushion at the front of each rear spring.

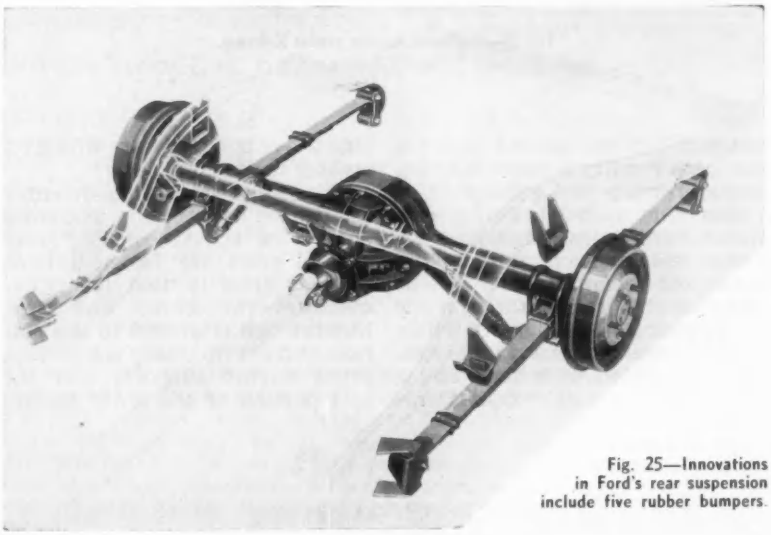


Fig. 25—Innovations in Ford's rear suspension include five rubber bumpers.

Frame Designs . . .

. . . are unorthodox and ingenious in many cases to permit lowering of cars, to accommodate new bodies, and to provide additional strength and stiffness.

FEATURE of Cadillac's new frame, for example is that the body is secured to outrigger mountings as shown in Fig. 26—instead of to frame side rails. Called a "tubular-center X-frame," the frame consists essentially of a tubular backbone from which arm-like beams V-out forward and rearward. The outrigger mountings of brackets extend out from the box-type beams. By varying the length of the center tubular section, the frame can be adapted to any of three Cadillac wheelbases. The new frame is claimed to provide greater torsional strength and stiffness without weight penalty. For example, Cadillac's new "Series 75" frame

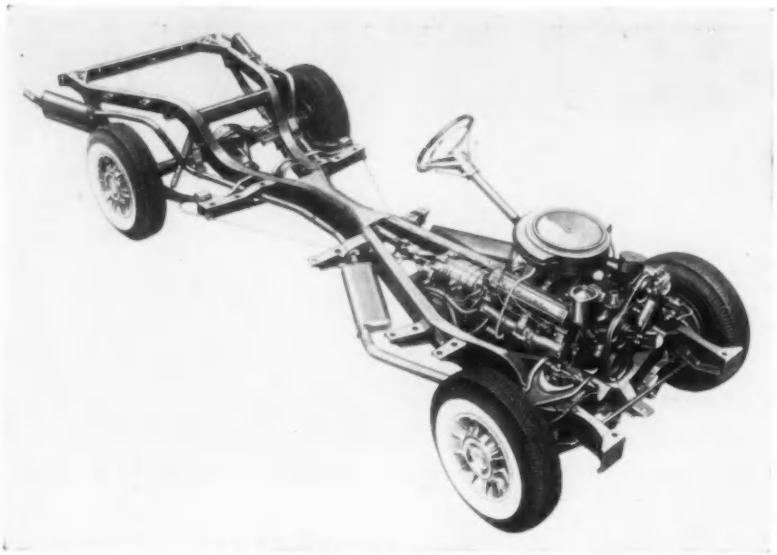


Fig. 26—Cadillac's tubular center X-frame.

weighs 3½% less than in 1956, yet torsional rigidity is improved 18% and stiffness is 16% greater.

The side rails of Ford's new frame flare sharply outboard between the axles, permitting the passenger compartment to be placed within rather than on top of the frame. (See Fig. 27.) These heavier gage, box-section side rails in combination with the greater use of tubular cross-members provide the entire structure with 27% greater torsional rigidity.

The frame front cross-member is a capped hat section. The front portion of the suspension lower control arms are fastened here. Tubular steel is used for cross-members two, three, and four. Number two is welded to the side rails and curves under the engine. Front engine supports and the rear portion of the lower control arms are attached to this member. Cross-member number three, located behind the transmission and under the front seat provides a base for the engine rear mounting bracket. Number four cross-member is positioned on the frame rear kick-up and mounts the upper ends of the rear shock absorbers. The side rails are joined at the rear by a channel type cross-member.

All body mounting brackets are of the offset type and there are no instances where the body is attached directly to a frame component. By utilizing all outrigger or inrigger body mounts, road shocks and harshness are reduced by virtue of the greater flexibility of these mountings as compared with the direct-body-to-frame mounting. By restricting the length of these rigger mounts, greater stiffness is realized in the combined body and frame structure.

Five variations of the basic frame are used for the 17 models offered.

The basic frame for the Mercury sedans is of ladder-type construction similar to Ford's with box-section side rails and five cross-members of boxed hat, tubular, and channel types.

The frame is 12.5 in. longer and 14.5 in. wider than the 1956 Mercury frame and features a kick-out ahead of the rear kick-up, thus permitting the depressed rear floor pan to fit down between the frame side rails providing adequate foot room and a low silhouette.

The Oldsmobile "88" frame is 45 lb heavier, and the "98" frame is 67 lb heavier. The frame side rails have been widened to permit lowering the floor and to provide body mountings nearer the rocker panel. Side rails are 4 in. farther outboard, making a total width increase of 8 in. Outrigger brackets are 3.22 in. shorter.

In new frames for Chrysler Corp.'s models straight-through side members are completely boxed to offer more resistance to torsional loads and greater inherent strength. Two front cross-members are now used, the forward one for bumper and radiator support and strut attachment, the second for engine and suspension support. Separating these functions permits the design of each cross-member to be improved, adding to the torsional rigidity. Longer frames allow shorter, stiffer bumper supports.

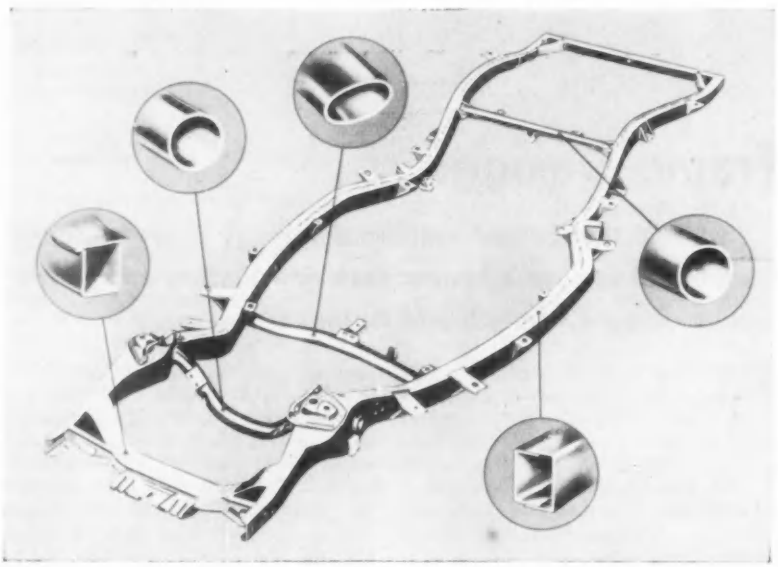


Fig. 27—Side rails of Ford's new frame flare sharply outboard.

Brakes Feature . . .

. . . improved performance, better cooling, and accommodation to new car designs. More powerful engines are objectives of changes in brakes.

LOCATION of Buick brake cylinders has been removed from the toe-board and placed at the left ventilation air-duct cover assembly. A common mounting for both power and manual cylinder assemblies provides interchangeability and flexibility to the system.

The separating piston on the Buick power brake has been supplanted by one having a solid piston with a pressure relief valve as an integral part of the piston. During normal power brake applications, the spring-loaded relief valve remains closed and is held in its seat both by an installed spring load of approximately 1 oz, and by added force caused by the pressure differential between the pressure and vacuum sides of the power piston.

The function of the pressure relief valve on the power piston is to provide instantaneous braking non-power brake applications. The valve provides passage for air during rapid movement of the power piston during engine-stall braking, and therefore prevents the compression of air at all times. An increase in reserve vacuum tank capacity, from about 180 to 360 cu in., allows the power brake to be applied 6–8 times, as compared with the old 2–3 times, in cases of engine stall.

Mercury rear wheel braking was increased from 37% in 1956 to 41% of the total in 1957. Brake size was increased on the rear wheels from 2.00 in. on the 1956 Mercury to 2.50 in. on all 1957 Mercury models and on front wheels from 2.50 in. on the 1956 Mercury to 3.00 in. on 1957 Mercurys equipped with the 368 cu in. engine.

An improvement in the 1957 Ford brake system has been made possible by the spindle forging—which combines spindle, spindle support, and steering arm all in one piece. The front brake anchor pins are mounted directly in this forging. This results in permanent alignment and a reduction in unsprung weight because the brake shield serves only as a shield and, since it has no structural significance, can be made of a much lighter material.

In their 1957 models, Pontiac and Cadillac have replaced their hand-type parking brake with the foot-operated design using a cane-type lever for release.

Oldsmobile's brake drums have been flared at the outer edges to improve cooling, and a dish-shaped deflector, spot-welded to the backing plate, has been added to seal out dirt and water.

Chrysler Corp.'s floating-shoe "Total - Contact Center - Plane" brakes, introduced on 1956 Imperials, Chryslers, and DeSotos, have been extended to Plymouth and Dodge.

Tires, Rims, and Wheels . . .

. . . feature adoption of 14-in. tires, rims, and wheels by the majority of American cars. Advantages claimed for them are lower cars, better ride, and improved styling.

SPECIFICALLY, cars using them include Chevrolet, DeSoto, Dodge, Ford, Hudson Hornet, Imperial, Mercury, Nash Ambassador, Oldsmobile, Plymouth, and Pontiac. In every case the 14-in. tires are of larger cross-section than the 15-in. tires they replace. This increased air volume permits them to carry the same load with less air pressure.

Consequently, the recommended pressure has been decreased to 21, 22, or 24 psi (cold). For some cars, the recommendation is 24 psi for front tires and 21 or 22 psi for rear tires. The larger cross-section has been obtained by an increase of about 10% in tire width. Since the inflated section height is usually approximately the same as that of the 15-in. tire replaced, the shift to 14-in. tires, wheels, and rims contributes about ½ in. to lowering of these cars. Because of its larger cross-section, each 14-in. tire will contain more material and weigh slightly more than the 15-in. tire that it replaced. With the overall diameter lowered and the sectional width increased, stylists claim that an optical illusion is created and the tire looks smaller in diameter than it really is. Rims are, of course, wider to accommodate the wider tires.

Steering in 1957 . . .

. . . stresses safety and ease in both manual and power steering developments.

DEEP-DISH safety steering wheels have been adopted as standard or optional equipment on virtually all cars. They are available in a wide range of attractive designs, materials, and colors.

Buick's manual steering gear will have a ratio of 23.6/1 compared with the 25.8/1 ratio used in 1956. Instead of the former trunnion-type mounting, the entire gear assembly has been lowered in the frame and mounted in the same manner as the power steering gear. Ball thrust bearings replace Spher-Angular bearings on the worm shaft. To reduce steering effort under parking conditions, needle bearings replace bronze bushings for the pitman shaft and side cover.

Buick's manual steering linkage will contain anti-wheel-kick springs at the pitman arm ball. Using the same steering arms with both linkages, the pitman and idler for the power linkage are longer than those for the manual linkage. These different lengths result in a 1.12/1 linkage ratio on

power steering to give fast response and a 1.22/1 manual ratio to reduce steering effort. The power steering pitman shaft has been shortened and the entire gear assembly lowered in the frame side rail. As a result, the angle between the steering shaft and the horizontal has been increased 3 deg to 29 deg 24 min.

To reduce steering effort, the Ford pitman arm length has been reduced 0.36 in. This change in geometry is responsible for the increase in overall steering ratio from 25.3/1 to 27.0/1. Despite this increase in overall ratio there is no increase in the number of steering wheel turns from lock to lock.

Studebaker has gone from twin-stud to single-stud steering gear on all V-8-engine-equipped cars. As a result the steering gear diameter has been reduced, the steering ratio has been decreased, and the wheel turns reduced from 5¾ to 4½.

Steering ratio of the Nash Ambassador and Hudson Hornet has been decreased from 20/1 to 18/1.

A new sleeve-type power steering pump has been adopted for the 1957 Imperial Chryslers and Plymouths. The pump is capable of high capacity at low or idle speeds. This means that the full pressure of the pump (900 psi) is available when parking. The pump-and-reservoir unit is mounted at the front of the engine and is driven by a belt from the crankshaft. Because of the high volumetric efficiency and larger displacement, the drive ratio has been reduced from 2.1/1 to 1.37/1.

New Lighting . . .

. . . is a four-lamp dual sealed-beam system. This new roadlighting system features improvements made in lighting and electrical systems.

IT was developed cooperatively by engineers of the automotive industry and the American Association of Motor Vehicle Administrators. SAE Committees have developed standards for it.[1]

The system is available as optional equipment in slightly different form for use in states where current laws permit them on the Nash Ambassador, Chrysler, Chrysler Imperial, DeSoto, and Cadillac Eldorado Brougham. The "Quadra-Lites" provided on Lincoln and the Mercury Turnpike Cruiser are similar in appearance but different in principle and operation.

Chief feature of the new system is the improved lower beam, made possible by a separate pair of units designed specifically for the lower beam. Each filament supplying the lower beam is at the focal point of its reflector where the best optical control can be obtained. Each of the units providing the lower beam also has another filament which provides *part* of the upper beam. The remainder of the upper beam—the more important portion which furnishes illumination for distant seeing—is provided by another single-filament unit, which also has its filament at the focal point of the reflector.

Thus the entire lower beam is provided by a filament at the focal point, and the important part of the upper beam is also provided by a filament at the focal point. Each of the four units is 5¾ in. in diameter. Each lower beam unit has a 50-w lower beam filament at focus and a 37½-w filament not at focus which provides part of the upper beam. Each upper beam unit has a 37½-w filament at focus. Switching is the same as with the single 7-in. sealed beam system.

The system is designed so that the lower beam is projected about 50 ft farther down the right side of the road and to cut off the rays of light that tend to escape upward, thus reducing the reflected glare-back from particles in the air and improving visibility in fog, snow, dust, or rain.

In the Nash Ambassador application, the dual headlamp units are mounted one above the other vertically with the lower beam units on top. In the Chrysler Corp. arrangement, the dual units are mounted side by side horizontally with the higher beam units inside, and the lower beam units outside.

In the Lincoln and Mercury Turnpike "Quadra-Lites," 5¾ in. "road lamps" are positioned below the standard headlights (each unit contains a 50-w upper beam and a 40-w lower beam filament), providing the driver with the option of using headlights for country driving and the 35-w road lamps for city driving, or both road lamps and headlamps together. The road lamps supplement either the upper beam or lower beam of the headlights by increasing the illumination directly in front of the car.

Parking, stop, and directional signal lights have also undergone considerable change in design and arrangement. For example, Lincoln introduces dual-purpose parking lights positioned in the leading edges of the front bumpers. They utilize two separate bulbs and lens areas to act as both parking lights and front directional signals. The outer lamp in the dual combination acts as a turning indicator. When the combination is used as parking lights, both the inner and outer section is in operation.

In the Chrysler Corp. line, parking turn-signal lights are positioned horizontally beside and just inside of the headlights unless the 4-lamp roadlighting system is used. Where the 4-lamp system is used, the upper beam units replace the parking turn-signal lights.

Virtually every 1957 engine has been provided with a new distributor, and many with new batteries to handle the increased lighting loads. Ford Motor Co.'s distributors now incorporate both vacuum and centrifugal spark advance systems. A window has been added to the side of those used in General Motors cars, Nash Ambassador, and Hudson Hornet, making possible adjustments while the engine is idling. Buick and Oldsmobile's new higher-capacity batteries are rated at 70 amp-hr.

[1] See SAE Journal, October, 1956, Pg. 52–59: "New 4-Lamp Dual Sealed-Beam Lighting System."

Guided Missile Recovery . . .

. . . would reduce the fabulous cost of development. Here are suggestions for a system to retrieve missiles without major damage to them.

Based on paper by **Bill L. Coffey,** Student, Northrop Aeronautical Institute

A SUGGESTED recovery system for small, light missiles is shown in Fig. 1. The design consists of a four-pod unit mounted on a cylinder encircling the missile body. The pod units comprise a vane, its erecting mechanism, and a shroud. The electronic portion would consist of a transistor radio receiver, a relay, and a battery. These could be mounted in the nose of the pods.

The system may be actuated at any time while the missile is in flight. This is done by a ground signal to the radio receiver which in turn closes the relay and allows current from the battery to flow to four explosive bolts serving as hold-downs for the vanes. With the hold-down severed, the spring forces the vane away from the missile body 5 deg. Due to the placement of the vane with the shank, the angle of attack is sufficient to cause rotation of the entire missile and vanes. The cross-section of the vanes is an airfoil of the circular arc type. The angular rotation of the missile sets up a centrifugal force which tends to throw the vanes to the out and locked position. The missile with vanes extended is shown in Fig. 2.

The frontal area of the vanes in the partial and fully extended positions serve as air brakes to slow the missile, much as the speed brakes on jet type aircraft. The center of gravity of the recovery system in the retracted position must coincide with the center of gravity of the missile with the propellants expended. As the vanes move outward, the center of pressure remains behind the missile's center of gravity and prevents tumbling. The vanes are prevented from retracting by the use of a ratchet mechanism. As the missile slows, it begins to stall and turns tail first to the earth. This turning is accomplished by placement of the vane hinge point forward of the missile's center of gravity. This places more of the weight aft of the hinge point. As the missile stalls and begins a vertical descent, the rotation stops and changes direction. Since the vanes are airfoils with a positive angle of attack, the entire missile functions much as a helicopter in an auto-rotation descent.

By combining the proper airfoil and vane angle, the angular rotation will not exceed the set 100 rps and the vanes will have enough lift to let the missile meet the earth at a velocity low enough to prevent major damage. By allowing tail-first touch down, a great deal of the remaining impact force could be absorbed by the tail fins. (Paper "The Design of a Dynamic Braking Device for Recovery of Ballistic Type Guided Missiles" received the 1956 Mac Short Memorial Award, sponsored by SAE Southern California Section. It is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

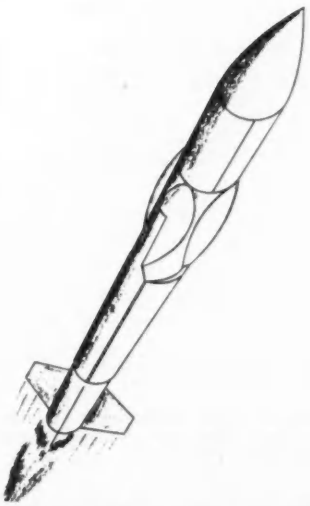


Fig. 1—Guided missile with recovery system. Note the four vanes mounted on cylinder encircling body, retracted as they would be in flight.

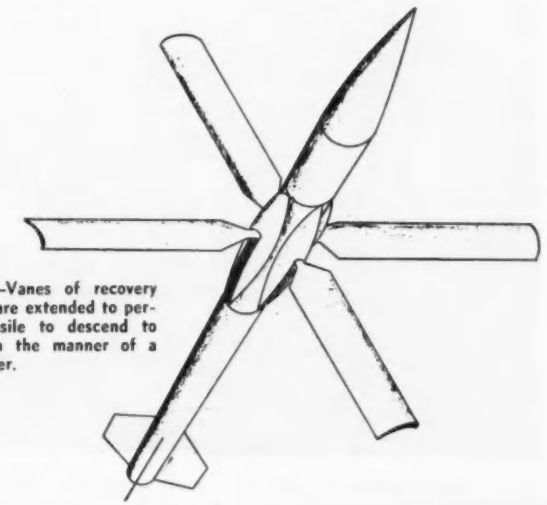


Fig. 2—Vanes of recovery system are extended to permit missile to descend to earth in the manner of a helicopter.

Cooperative Studies Are Solving Mysteries of *Diesel*

Hot-Motored Technique

From Yu-Uyehara-Myers-Collins-Mahadevan

THE hot-motored technique is a useful method for studying the very small pressure changes that occur with different fuels during ignition delay in an operating diesel engine. With it a truly hot, motored pressure diagram can be compared with a fired pressure-time diagram.

Description of Technique

With the engine operating normally on the test fuel (except for certain inlet air and governor modifications), a pressure-time record for a single fired cycle is obtained. On the next cycle, the solenoid pulls the injector rack back to the no-fuel position and the drum camera also records this hot-motored cycle on the same film as the fired cycle. Thus, two successive cycles—the first fired and the second unfired—are obtained on a single film. In both cases the vertical pressure scales are expanded so that only the high-pressure portion of the compression

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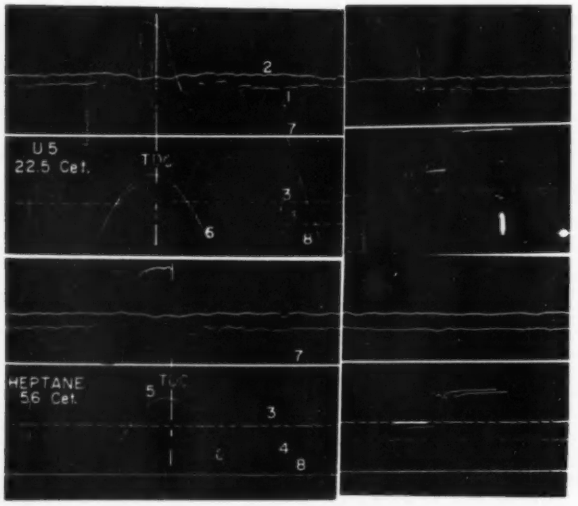

Fig. 1—Typical oscillogram taken when using hot-motored technique (from Yu et al.)

Components of Ignition Delay

From El Wakil, Myers, and Uyehara

THE ignition delay period can be divided into the following phases:

1. Injection delay.
2. Fuel vaporization delay.
3. Chemical delay.

Actually, some chemical reactions take place during vaporization and, at times, the two phenomena may take place simultaneously.

Both the injection delay and the fuel vaporization delay periods constitute an appreciable part of the total ignition delay period, as shown in Fig. 2.

Injection Delay Period

There may be some question whether this is properly included in the ignition delay period. Data show that the time between the beginning of injection (measured by a strain gage on the rocker arm) and the time of measurable pressure drop

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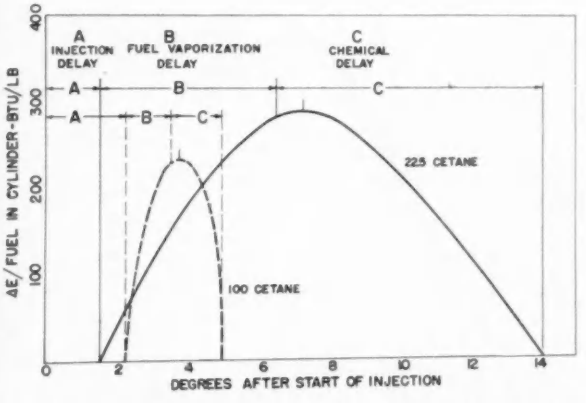


Fig. 2—Heat transfer per pound of fuel in cylinder after injection, showing components of ignition delay in diesel engine for fuels of two different cetane numbers (from El Wakil et al.)

Ignition Delay

Constant-Volume Bomb Tests

From Hurn-Chase-Ellis-Hughes

TESTS in a constant-volume combustion bomb show that chemical heat release occurs only after an appreciable time interval, during which the fuel is heated and may be partially or wholly vaporized.

The rapidity of this heating—and associated ignition delay—is influenced markedly by the physical properties of the gas surrounding the injected fuel particles. Fuel volatility and chemical structure have relatively little influence on the rate of heat transfer to the fuel in the prereaction period.

In particular, the constant-volume bomb tests

Leading Researchers Talk on Ignition Delay

THIS article brings together some of the main points made about ignition delay in three papers by 10 of the industry's leading researchers in this field.

Ignition delay—the time between the injection of the fuel into the cylinder and its involvement in rapid combustion—is of extremely short duration. (In a high-speed diesel, it may last for a millisecond or two—or even less.)

For this reason, it has been necessary to develop new techniques for studying the phenomena that occur.

AT THE UNIVERSITY OF WISCONSIN, a hot-motored technique has been developed, so that the delay period can be studied in an actual operating engine.

BUREAU OF MINES studies, on the other hand, have been made in a constant-volume combustion bomb. The advantages of using the bomb are that a high degree of precision can be obtained in both temperature and pressure control, and the flexibility with which conditions of operation may be chosen.

The Authors	The Papers
1. T. C. Yu, O. A. Uyehara, and P. S. Myers, University of Wisconsin; R. N. Collins, Continental Oil Co.; K. Mahadevan, Indian Institute of Science	"Physical and Chemical Ignition Delay in an Operating Diesel Engine Using the Hot-Motored Technique"
2. M. M. El Wakil, P. S. Myers, and O. A. Uyehara, University of Wisconsin	"Fuel Vaporization and Ignition Lag in Diesel Combustion"
3. R. W. Hurn, J. O. Chase, C. F. Ellis, and K. J. Hughes, Bureau of Mines	"Fuel Heat Gain and Release in Bomb Autoignition"

These papers were presented at the SAE Golden Anniversary Diesel Engine Meeting, St. Louis, Nov. 4, 1955. All three papers, plus written discussion, have been printed in full in the 1956 SAE Transactions.

Presented herewith are a short description of the hot-motored technique and some of the data reported by these investigators.

Constant-Volume Bomb Tests—continued from preceding page

provided helpful information on the following:

1. How transfer of heat to the injected fuel is influenced by the thermal characteristics of the gas into which the fuel is injected.

2. How the release of heat during autoignition is influenced by the thermal characteristics of the inert gases in the reacting mixture.

3. How some ignition modifiers affect heat transfer during the prereaction period.

Influence of Thermal Characteristics

The following conclusions are based on tests with two fuels of widely different volatility but about equal cetane number (one, a relatively volatile mixture of 33% isooctane and 67% normal heptane, and the other a low-volatility mixture of 40% normal cetane and 60% alphamethylnaphthalene—both mixtures rating 40 cetane number). Bomb atmospheres in the tests were the inert gases; helium, nitrogen, and argon. It was concluded that:

1. The heat absorbed by the injected fuel within a given time interval increases in the same order as the thermal conductivities of the gases into which the fuel is injected.

2. The rate of heat absorption is not materially influenced by the quantity of fuel injected except during the terminal period of heat transfer.

3. Limited data seem to show that higher fuel volatility does not, in itself, result in faster transfer of heat to the fuel.

Heat Release Data

The data covering heat release after autoignition of the fuels show that:

1. Helium atmosphere is conducive to the earliest heat release. Probably this can be explained on the basis that its higher heat conductivity causes faster heating of the fuel and earlier attainment of an equilibrium high temperature.

2. Argon atmosphere is least conducive to early heat release. Since argon and helium have identical specific heats, these differences are probably explained on the basis of differences in heat conductivity. This effect is particularly pronounced in the earlier phases of fuel injection. For later phases, diffusivity factors may be controlling.

3. The data for the isooctane-heptane mixture show greater differences between atmosphere than the data for the lower volatility cetane-alphamethylnaphthalene mixture.

4. Lower temperatures accentuate the differences between atmospheres.

5. The staged heat-release phenomenon is more pronounced for the cetane alphamethylnaphthalene mixture than for the isooctane-heptane mixture.

Additives

To obtain information regarding the influence of additive materials on heat transfer during the prereaction period, data were taken on a commercial diesel fuel treated with an amyl nitrate type of ignition improver and on a high-quality kerosene to which tel had been added as an ignition inhibitor. Comparable data also were taken on three different blends of normal cetane and alphamethylnaphthalene.

From the data it appears that the greatest difference between the autoignition behavior of fuels lies in those factors that affect chemical reaction, rather than in those factors that affect physical processes. However, it must be kept in mind that fuel atomization, spray formation, turbulence, contact cooling, and other mechanical factors may markedly affect temperatures that vitally influence the course and time-history of chemical reaction.

Hot-Motored Technique—continued from page 38

stroke shows on the oscilloscope and is recorded.

Typical oscillograms are shown in Fig. 1. The events shown on this oscillogram are:

1 and 2: Voltage output of the strain gage on the rocker arm during fired and hot-motored cycles, respectively.

3 and 4: Timing marks for the fired and hot-motored cycles, respectively. These timing marks were automatically shifted downward on the hot-motored cycle by means of a relay to prevent overlap.

5 and 6: A much-expanded, pressure-time record for the fired and unfired cycles, respectively. The step functions shown on the right-hand side after the break in the film are caused by two calibration resistors being successively inserted into the pressure-pickup circuit. The pressure corresponding to the step shown is 50 psi.

7 and 8: Alignment lines for scaling purposes.

The hot-motored technique provides a reference cycle in which, except for the question of cyclic reproducibility, all conditions are exactly the same as in the fired cycle, except that no fuel is injected, that is, hot clearances gases are present, walls are hot, incoming air is heated by the walls and pistons, and so forth. Thus, any differences in pressure between the two cycles must be due either to

the fuel injected or to irreproducibility of engine and instrumentation.

This pressure difference, regardless of irreproducibility, is approximately proportional to the algebraic sum of the energy absorbed by the fuel for vaporization and the energy release due to exothermic chemical reaction. This energy balance is useful in the study of physical and chemical delays in diesel engines.

Except where specifically varied, engine operating conditions were held constant.

To maintain weight of fuel injected more nearly constant, the injector rack setting was changed slightly for different fuels. This explains in part the ±1½-deg variation experienced in the point of injection. A portion of the ±1½-deg variation, however, is caused by the irreproducibility of the determination of the injection point.

To study fuel vaporization with no oxidation reactions present, a nitrogen tank was connected by two solenoid valves to the plenum chamber surrounding the inlet air ports. This nitrogen tank was connected in the side of the plenum chamber opposite the entrance from the blower. The entrance to the blower normally connected to the atmosphere was connected to a 50-gal drum fed with house air. This same entrance could be connected to the atmosphere by means of a 2-in., solenoid-operated butterfly valve.

In operation, a pressure-time record was obtained with the engine firing normally and the solenoid valve closed. Just after the ports were closed on this fired cycle the solenoid valves were opened, flooding the plenum chamber with nitrogen. On the next cycle, the cylinder was scavenged and filled with nitrogen. When fuel was injected, a pressure-time record with vaporization, but no oxidation reactions, was obtained. For comparison, a hot-motored cycle using nitrogen but with no fuel injected was obtained. This technique is in the development stage, but it appears to have good possibilities.

Components of Ignition Delay—continued from page 38

due to cooling effect of fuel is not negligible. Data for primary reference fuels, secondary reference fuels, and pure fuels show that injection pressure reached 30–40% or more of its maximum value before measurable pressure drop occurred. Maximum injection pressure was probably of the order of 20,000 psi, so that an injection pressure of 6000–7000 psi had been achieved before appreciable heat transfer to the spray occurred.

Several explanations seem possible. The injector had an open nozzle. Fuel vaporization in this open nozzle might occur between injections, producing this effect. Another explanation might be that it was caused by spray breakup. Data indicate that the pressure drop occurs as soon as fuel is introduced. There was some evidence, however, of a small delay between injection and decrease in pressure due to fuel cooling when argon was used. Fuel compressibility might cause a time difference between injection (measured by a strain gage on the rocker arm) and the beginning of measurable pressure drop. Because of the short distances involved and the low opening pressure of the nozzle valve, however, this explanation does not seem too plausible.

Fuel Vaporization Delay Period

Once spray breakup begins and spray starts to form, data indicate that, while there is some difference between fuels in rate of heat absorption from air, these differences are not large. Here differences in fuel distribution within the spray and during atomization become important. De Juhasz and his associates state that as oil viscosity increases, mean droplet diameter decreases. It is also stated that fuel dispersion in a given cross-sectional area becomes more even as fuel viscosity decreases and distance from the orifice increases.

When the fuel droplets are formed, they are affected by aerodynamic drag forces and diffusional and heat-transfer effects. Fuel droplets in the spray fringes will vaporize independently of each other. The temperature of the air surrounding them will remain high enough to cause the combustible mixture formed in the air-vapor film surrounding the droplet to self-ignite. The droplets in the center of the spray are so close as to affect each other. A state of adiabatic saturation will ultimately occur, with consequent large cooling effects (several hundred degrees).

Lower viscosity fuel spray will have smaller average droplets than fuel of high viscosity. Further, a less viscous fuel is likely to be more volatile. Both

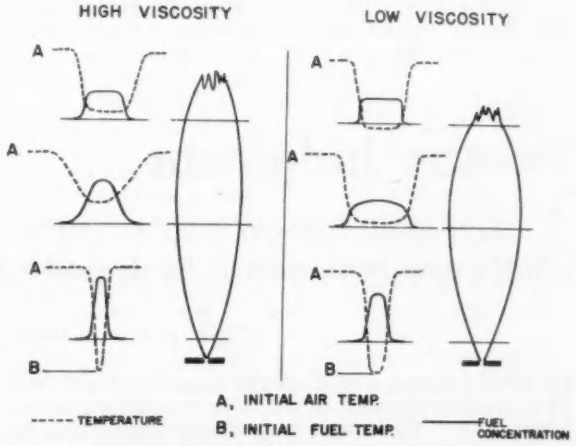


Fig. 3—Fuel and temperature distribution for sprays of fuels of different viscosities (from El Wakil et al.)

these factors will cause the less viscous fuel to approach adiabatic saturation more rapidly.

Fig. 3 schematically presents the relationship between fuel distribution, estimated temperature distribution, and distance for two fuels of different viscosity.

The middle left-hand curve in Fig. 3 suggests a better possibility of self-ignition occurring because of the more gradual change in temperature and fuel/air ratio with distance. It is no coincidence then that ignition usually starts at the spray edge and not in the center or tip of the spray.

Fig. 3 also illustrates why ignition delays obtained in a combustion bomb are longer than those obtained in operating engines. Macroscopic turbulence (as opposed to microscopic turbulence) tends to bring fresh air into the spray center and thus aids in eliminating adiabatic saturation conditions and increasing the possibilities of achieving a combustible mixture at self-ignition temperature. This same reasoning also explains the decrease in ignition delay with an increase in engine rpm, although the compression temperature undoubtedly increases somewhat with rpm.

Chemical Delay Period

With the conditions within the spray that lead to the formation of a combustible mixture at its self-ignition temperature established, the next thing to consider is the time required for the reactions to become explosive, namely, chemical delay. Here there is a marked difference between fuels. Data show very clearly that before the reactions become explosive, chemical energy is released at different rates for different fuels, and that additives affect this rate. This correlates well with the inverse relationship between the cetane and octane scales. If physical conditions are fixed, physical delay would not be zero or even negligible, but would be approximately constant for fuels whose physical properties do not vary widely. Thus, differences between fuels would result largely in differences in chemical delay.

Tool Control . . .

. . . is handled effectively in some plants without a Tool Control Department, as such. Here's how it's done in one factory.

Based on secretary's report by **E. J. Hall,** Lockheed Aircraft Corp.

ONE aircraft company, which has no Tool Control department as such, divides its tool control within the individual tool making departments by supervision and one or two tool engineers.

It functions in two ways:

I—Either Tool Design or a department about to go off schedule on a tool will notify the using department of the off-schedule condition. Included will be a promise date for completion.

Then the using department examines the situation. If it can still meet its schedule it takes no action. If the promise date is unsatisfactory, an investigation will result in a reschedule, late installation or extended use of overtime, depending upon the specific conditions. (Off-schedule tool work totals about 10%.)

II—Charts are set up by a tool engineer to show all large or hard-to-make items. These charts bear the approval of all persons who are to be held to the schedules shown.

It is felt that if the people manufacturing the tools have full knowledge of the amount of time allocated and a voice in these allocations it will create a greater personal interest.

(This article is based on the secretary's report of panel on "Tool Control" held at SAE National Aeronautic Meeting and Production Forum, Los Angeles, Oct. 11, 1955. This report together with 14 other panel reports is available as SP-313 from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: $2.00 to members, $4.00 to nonmembers.)

Human Judgment . . .

. . . stays a key factor in even automated quality control. There are few plants from which a product would ever be shipped if it had to conform exactly to the blueprint.

Based on secretary's report by **R. C. Ochs,** Axle Division, Eaton Mfg. Co.

HUMAN judgment will always remain a key factor in quality control, despite continued advance in techniques. Data resulting from application of quality control formulas usually point the way to —rather than dictate—subsequent action.

Blueprints, for example, are not always exact enough to eliminate the chance of misinterpretation. Not all specifications have blueprint limits which the shop must work to. Some include what might be called "judgment items." To handle the "judgment items" properly, the inspection department has to participate in working committees with

other plant departments, visit competitive plants, and exchange ideas with outside inspection personnel.

Sometimes, blueprint dimensions aren't even available. Then, the inspector's knowledge, gleaned from these outside contacts, and his understanding of the product's end use, stands him in particularly good stead.

The automated gaging sported by some new machine tools merely transfers human quality control of the part to the machine. It doesn't eliminate the need for judgment and control by quality control and inspection people. Besides, these automated devices are currently practical only in relatively high volume operations.

Also, blueprints and specifications must be constantly interpreted in the light of performance reports and service reports from field engineers. And human judgment continues to be a key to the more precise definition of quality levels which more and more is being sought. Interpretation of test model performance, field experience, and design elements is a main device by which this search is being made.

Finally, the judgment of experienced and knowledgeable humans is almost the only device available for answering the basic question:

"How can you tell essential quality from non-essential quality?"

Only after specific identification of that difference in a particular instance can the non-essential be culled out through cost reduction programs in both manufacturing and inspection departments. And such reductions are essential, because quality control which doesn't improve the product does increase the cost. So, failure to differentiate non-essential quality can result in a manufacturer's eventually pricing himself out of a market.

Generally, experience dictates where critical quality points are. But competition can create new ones. So constant vigilance and exchange of ideas with outside sources by competent quality control personnel is essential.

(The full secretary's report from which this abridgment was made is available together with the reports of six other panels held at the 1956 SAE National Production Meeting and Forum held in Cleveland, March, 1956. Price: $1.50 to members; $3.00 to nonmembers.)

Members of this Panel on "The Customers Point of View" were: R. D. Long, Motor Truck Division, International Harvester Co., chairman; R. C. Ochs, Axle Division, Eaton Manufacturing Co., secretary; Keith Evans, Motor Truck Division, International Harvester Co.; F. Galbos, White Motor Co.; R. Kenney, General Motors Truck Division, GMC; C. W. Leslie, Motor Truck Service, International Harvester Co.

Pound-Wise . . .

. . . and plane-foolish, the engine designer can be, if he cuts engine weight at the expense of overall airplane safety, reliability, or efficiency.

Based on paper by **M. G. Beard,** Assistant Vice-President for Research and Development, and **F. W. Kolk,** Research and Development Engineer, American Airlines, Inc.

BECAUSE it's the overall airframe-plus-powerplant combination that counts, a few extra pounds added to turbine engines in the interest of safety or reliability may be well worthwhile, from the airline viewpoint.

Engine cases illustrate the point. Loss of a single blade on a turbine wheel can so unbalance the wheel that the uneven centrifugal forces tear it apart, allowing the pieces to fly off tangentially against the engine case. Or overspeeding may cause centrifugal stresses to exceed strength of the wheel and burst even a previously undamaged wheel. In either case, the kinetic energy of the pieces may enable them to rip through the case if it has been designed just strong enough for normal operation. Once outside the case, the flying pieces may open up fuel lines, creating a fire hazard around hot parts; sever hydraulic or pneumatic control lines; or penetrate the fuselage to endanger passengers or crew.

To lessen all these hazards, the airplane designer can provide lavish gadgetry to insure against overspeeding and to extinguish engine compartment fires, and extra-rugged skins on fuselage and wings.

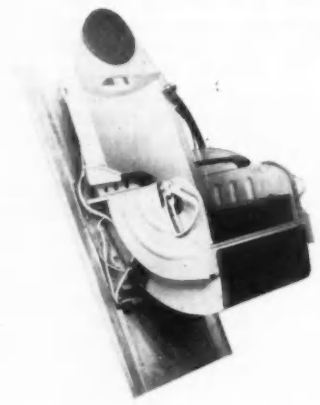
But the goals of safety and reliability will very likely be better served if some of the weight is alloted instead to sturdier engine cases.

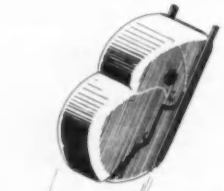
(Of course, strong cases are only one factor in containment. Reduction of kinetic energy of the rotating parts by reducing their weight, diameter, or rpm—or all three—helps too.)

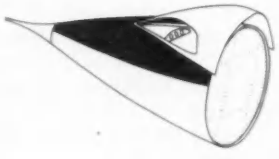
Similarly the added weight of rigid supports for the inner ends of compressor stators may be justifiable on ground of reliability. Experience has shown that a shrouded compressor can swallow a handful of ¼-in. bolts and keep running. One such bolt ingested into an unshrouded compressor can wreck it in a revolution or so.

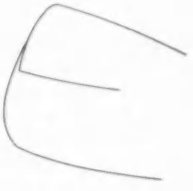
(Based on paper "Some Safety Aspects of Gas Turbines" presented at SAE National Aeronautic Meeting, New York, April, 1956. Complete copies are available in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Progress Is Steady Toward Solution of Acute









PROGRESS is steady toward solving the unsurmounted problems of pilot escape from disabled aircraft. But ever-faster planes flying higher and higher keep increasing the acuteness of the problems, even as better understanding of them grows apace.

Nearly 30% of the crew members ejected in 400 "successful ejections" performed by Air Force crews in 1954 were killed—mostly through contact with the earth. Another 17% sustained major injury . . . although more than half (53%) escaped uninjured.

Progress is taking the form of:

- Isolation and definition of the varied kinds of hazards which beset the crewman after, as well as before, a successful ejection.
- Improvements in ejection seat design that would complete the ejection so as to give ejected crewmen maximum protection against these after-ejection hazards.
- Relation of both of these factors, in turn, to the maximums of human endurance, both during and after the actual ejection has taken place.

Important among the deterrents to getting safely separated from the aircraft when ejected may be: (a) incapacity of the crewman to operate the ejection apparatus; (b) abnormal attitudes of the aircraft itself . . . of all ejections performed by Air Force crews in 1954, more than half occurred with the aircraft in abnormal attitudes; and (c) failure of the escape mechanism to operate perfectly . . . although this seldom occurred in the records mentioned.

But once separated from the aircraft, the ejected

Pilot-Escape Problems

Lt.-Col. John P. Stapp, Holloman Air Development Center

and

R. J. Heymans and R. M. Stanley, Stanley Aircraft Corp.

Based on Stapp paper "Human Factors of Supersonic Escape" and on Heymans-Stanley paper "Crew Survival in the Jet Age." Both papers were presented at the SAE National Aeronautic Meeting, New York, April, 1956.

crew member is faced with many more potential hazards to his safety. Among the possibilities are:

- Harmful air blast effects—which may result either in physical injury or loss of equipment.
- Adverse effects from linear and angular acceleration.
- Failure to avoid the aircraft's tail, landing gear, or other parts.
- Failure of oxygen and pressure supply.
- Harm from parachute opening—and enemy action.
- Impact with the earth's surface.

The ideal escape system, of course, will offer the minimum compromise of aircraft performance that will still provide adequate coverage of the maximum probable escape conditions. But also, in keeping with American military tradition, it will aim to save the life of the crew, irrespective of cost.

Incapacitation

Incapacitation before or after ejection may occur from a variety of causes, not the least of which is fear and panic. Contributing causes include battle injury, hypoxia, and other physical disablement.

At altitudes above 30,000 ft, a long, free fall and attendant tumbling and spinning become increasing hazards alleviated by stabilizing the escape system and its occupant.

The rate of random tumbling and spinning becomes higher as atmospheric density diminishes. Edelberg and his associates found through ground experiments that 160 rpm for 12 sec could produce loss of consciousness. In actual free fall, Nielson and Sperry encountered nausea, vomiting, and disorientation at velocities of 90 rpm or less.

Other Pre-ejection Problems

Modifying subsonic ejection seats to make them suitable for supersonic aircraft to save occupants from disaster at maximum performance is a most urgent immediate problem. To solve it requires evaluation of a number of specific mechanical factors.

The catapult which ejects the seat imposes a load on its occupants varying from approximately 7*g* to 15*g*. At the higher accelerations associated with upward ejection from high-speed aircraft, there have been many vertebra compression fractures, though few spinal cord injuries.

Yet, the catapult force must be high enough so that the seat and its occupant will clear the fuselage and tail at all speeds and attitudes for the required direction of ejection . . . upward, downward, or canted upward. So, this may require revising the suspension of the occupant in the seat to get greater exit velocities with a shorter catapult stroke and cleaner separation from the seat tracks. This can be achieved by locking the helmet and head to the headrest, thus relieving the spine of 15 or 16 lb of load. (At 30*g* this would be about 450 lb.)

The weakest part of the vertebral column under vertical compression is the upper lumbar spine, in the lower flexible curve of the back. A band around the chest attached at the two upper corners of the back of the seat can uphold part of the weight of the torso while preventing displacements that would shear the neck. Expanded foam plastic in the seat

cushion to a thickness that would permit 2 or 3 in. of downward displacement would absorb energy of the upward ejection and prevent oscillations between upper and lower segments of the trunk. Accidental exposures to 30–33*g* at 500*g* per sec rate of onset have been sustained without injury under ideal laboratory conditions without such support. So, it is certainly reasonable that ideal positioning and support of the spine for ejection forces in aircraft should be just as tolerable.

It is understood that all these supporting measures remain slack until they are automatically tightened during the ejection sequence.

Design for leg and arm retention is, also, necessary to reduce separation injuries (as well as blast injuries at high speeds). An incapacitated pilot cannot be expected to put his arms and legs exactly where they belong and hold them there during ejection. Support, therefore, should include positioning and securing extremities in faired housings for protection from windblast flailing.

Since human responses and coordination become unpredictably erratic under severe stress, it is proposed that a single switch accessible to either hand, suffice to actuate the whole ejection sequence, from tightening restraints and jettisoning the canopy to firing the catapult.

The ejection procedure can be simplified still further by having the occupant ride the seat all the way. The parachute can then be attached to the seat and stowed in a housing at the top of the back of the seat. The seat can be made of energy absorbing materials and have compartments which would hold survival gear and provide flotation in a water landing.

A projecting foot rest, overhang of headrest, and fairings around the shoulders can provide protection from landing impacts. Tension in the harness could be released by a time delay control and the straps released manually thereafter. All exposed personal equipment, such as helmet and projections of garments should be windblast and tear proof.

All pre-escape procedures and controls, in fact, should be sufficiently simple—and the sequential operations sufficiently few in number—to permit a one-armed, blind man in a dazed condition to perform them properly. At extreme altitudes which can be foreseen for the future, it may be necessary to use propulsion to stabilize the escape system.

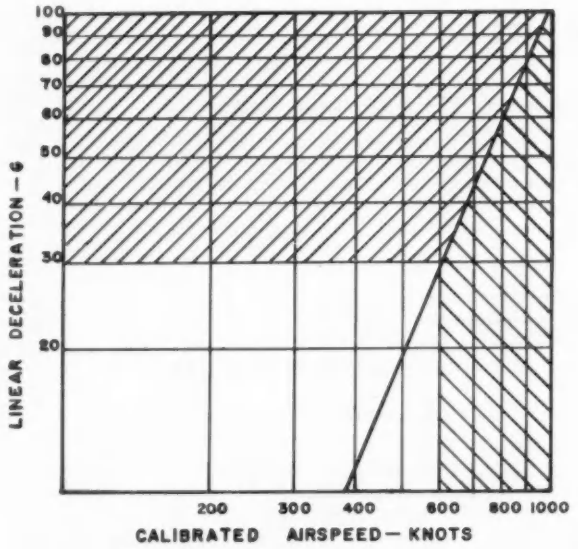


Fig. 1—Linear deceleration experienced by an escapee at various air speeds. For example, at 600 knots an ejected escapee may expect a linear deceleration of 30*g*. At 1000 knots, this rises to 100*g*—which is higher than the human body has thus far successfully withstood. (Heymans-Stanley)

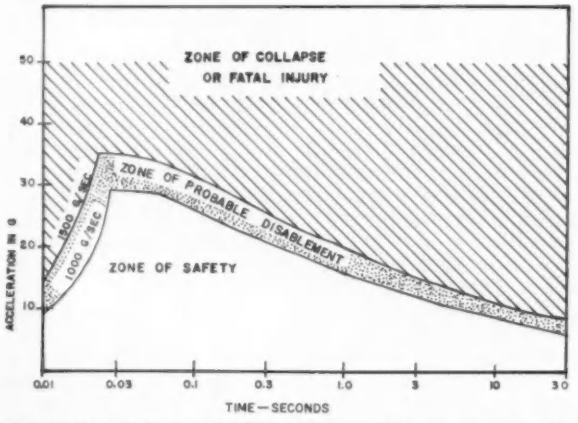


Fig. 2—Chart indicating the limits of human tolerance within which escape systems must be designed. (Heymans-Stanley)

Air Blast Effects

First among post-ejection hazards are air blast effects. They act upon the ejected crewman at the moment he has emerged from the outer shell of the aircraft. But, heretofore, and up to speeds of 500 knots, the number of injuries resulting from air blast have been surprisingly few. Jowls and ears flap alarmingly, but somehow the human face is tough enough to withstand terrific air blast as long as it comes from a single direction.

Arms and legs are not so fortunate, however. In recently reported experiments, Sperry and Nielsen of the Wright Air Development Center sustained fractures and dislocations from flailing during downward ejection from 30,000 ft and less than 500 knots.

Experiments with bare-faced animal subjects exposed to windblast at 600 knots or more have corroborated the occurrence of air in the stomach blown in through the mouth and nose, which was observed in the single human instance of survival of supersonic ejection, wherein the helmet was lost. In this instance, the estimated three liters of air in the stomach of the human subject substituted for flotation gear which he was in no condition to inflate.

The limiting factor for direct exposure to windblast will be the tolerance for magnitude and abruptness of wind forces approaching the level of explosion blast and for the accompanying shock waves and turbulence.

As speeds increase, limb retention and face shielding will be mandatory.

Linear and Angular Acceleration

Linear and angular accelerations of high magnitude occur almost inevitably at high speeds. Fig. 1 shows that at 600 knots an escapee may expect a

linear deceleration of 30*g*. At 1000 knots this rises to 100*g*—which is higher than the human body has thus far successfully withstood.

A man in an ejection seat is a high-drag body. So, streamlining him might alleviate the linear deceleration problem. But, as Fig. 2 shows, time must also be considered. When one analyzes the speeds of tomorrow's airplanes in the light of Figs. 1 and 2, the availability of a reasonable solution is not apparent.

A crewman, during the first one or two seconds after ejection, may be shaken like a terrier shakes a rat—and with equally fatal results. His body becomes a virtual cocktail shaker for his viscera. Only by improved stabilization can the ejection seat continue to be an effective escape device in speeds above 500 knots.

Avoidance of Aircraft

Avoidance of the aircraft is, of course, imperative. At any appreciable speed the escapee will have enough relative velocity by the time he passes the tail of the aircraft so that contact would be dangerous or fatal. It is this consideration which has caused catapults to exert forces up to the limit of human endurance in existing ejection seats. This limitation will impose an increasingly severe problem as flight speeds continue to climb.

In addition to the tail, there are, of course, such things as landing gear, bomb bay doors, and other items projecting beneath and above the airplane which offer their own hazards peculiar to downward or upward ejection.

Thus far ejection seats have confined themselves to going upward or downward. Some consideration has been given to ejection at oblique angles, aimed at avoiding the vertical tail surfaces. In almost all cases, these schemes have fallen short of their goal because of the unpredictable trajectory during violent gyrations.

Oxygen and Pressure Supply

Once an escapee has slowed down to non-injuries air speeds, his continued survival at high altitudes is dependent on his continued supply of oxygen . . . and possibly pressure as well. An oxygen supply and a mask that stays put are essential to insure consciousness for the escapee throughout the entire escape.

Parachutes—and Enemy Action

Floating gracefully down from 15,000 ft under a 28-ft diameter parachute, the escapee has ineffective concealment in daylight. So, he should be permitted to free-fall as long as possible before opening his parachute. Also, parachute opening at high altitude imposes shock loading on the human body beyond its structural capacity. That is why today's parachute automatic-opening devices are designed to deploy at reasonably low altitudes.

The human body isn't the best place to stow gear, either. An ejection seat which the occupant rides all the way to the earth, therefore, has more than passing merit. . . . The whole problem of parachute-man-seat integration, and the design of automatic controls in general, would be greatly alleviated by having the man and the seat stay together all the way down. Danger from injury under adverse conditions upon impact with the earth's surface might also be reduced.

Limits of Human Tolerance

Exact limits of human tolerance can only be approached experimentally by attempting to isolate a single factor in relation to a combination of calamities at a time. This, in turn, only approximates an estimate of the combined effect of several sets of factors.

During actual escape from high-performance aircraft, the victim is exposed to continually changing combinations of windblast, wind drag deceleration, tumbling and spinning on top of an extremely abrupt transition from cockpit pressurized environment to ambient outside pressures and temperatures. The ultimate proof of any escape system will require human experimental exposure to actual conditions of escape.

Any escape system which is in itself lethal or injurious is inadmissable. Therefore, the experimental approach to human factors of escape requires evaluating each factor under controlled conditions that isolate it from other factors as much as possible. Only thus can be determined the limits of reversible disability for the parameters of that factor.

Use of rocket sled decelerations excluding windblast and tumbling, for example, have established parameters of tolerance for rate of onset, magnitude, and duration of forces applied in the forward-facing seated position. This corresponds to the condition of upward or downward ejection at the instant of separation from the aircraft and before onset of tumbling or spinning.

The next step in the rocket sled technique is to determine tolerance to abrupt onset of windblast corresponding to jettisoning the canopy and ejecting into the wind stream. Accelerative and decelerative forces are kept below parameters for appreciable physiological effects by increasing the duration of acceleration and deceleration in order to reach higher maximum velocities. By jettisoning a windshield or canopy at maximum velocity with an abruptness comparable to canopy removal in supersonic flight, the effect of abrupt rise of wind pressure can be superimposed on the tolerable level of acceleration and evaluated. In these tests the subject is protected from windblast flailing by securing the extremities and from inflation through facial openings by enclosing the head in a wind-proof helmet.

There is no question of compromising the design of the aircraft or the effectiveness of the pilot in flight by the application of these protective measures. To date, human tolerance limits have not been reached either by experimental exposure to 1108 lb per sq ft of windblast pressure or by an estimated 1240 lb per sq ft of wind pressure incurred in a supersonic escape at Mach 1.05 and 6500-ft altitude. In the latter, head and face were exposed by the loss of a subsonic-type helmet during or shortly after ejection. Further experiments will be required to find this limit.

It is important to find this limit because the determining factor which would make capsule escape obligatory is tolerance to abruptly applied wind pressure against the body walls at high supersonic speeds. All other human factors remain to be dealt with whether or not there is a capsule. This state-

ment assumes that the abrupt change of cabin environment to ambient is compensated for by appropriate personal equipment such as pressure suits and emergency oxygen.

The limits of tolerance for tumbling and spinning have been experimentally investigated by Edelberg and Weiss of the Aeromedical Laboratory, Wright Air Development Center. With the heart as the axis of rotation a human subject lying on its side on a turntable is rendered unconscious in 10–12 sec by 160 rpm. Under the same conditions, 200 rpm proved fatal to animal subjects in two minutes.

In free fall from aircraft under conditions of tolerable wind drag deceleration and windblast, tumbling and spinning have been investigated by Sperry, Nielson, et al, from as high as 45,200 ft. The unpleasant and hazardous effects of this factor can be excluded by preventing its occurrence. This can be accomplished by aerodynamic stabilization with vanes or drogue chutes at atmospheric altitudes and by directional thrust above the atmosphere.

Capsules and Pods?

Capsules and pods offer the advantages of:

- Containing the cabin environment throughout the escape sequence.
- Protection from windblast.
- Adding weight to mitigate wind-drag deceleration.
- Permitting ogive shape streamlining to reduce drag area from 6½ sq ft in the open ejection seat to 3 or 4 sq ft.
- Permitting aerodynamic stability not possible in the seat configuration.
- Serving, if need be, as watertight shelters and as boats for arctic, desert, or sea survival.
- Providing convenient stowage of survival gear.

Chief disadvantage is that the aircraft has to be designed, as it were, around an escape device . . . when its primary mission is to fly and fight as efficiently as possible, carrying a minimum emergency dead weight, and presenting a minimum of drag area in flight. Other disadvantages:

- Greater weight requires formidable catapult or rocket charges, with scarcely tolerable jolts and peaks of separation forces when separated at high speeds and altitudes.
- More susceptible to battle damage that can still be survived by the occupant (who then needs an escape system from the escape system).
- Need for multitude of quick disconnects for electrical, hydraulic, pneumatic, and mechanical systems and controls is a design nightmare.

Right now there is little need for a partisan stand for or against capsules or ejection seats. The final choice must be determined by now incompletely known human requirements—and can be made only after these have been defined to applicable limits.

A dependable escape system engineered to human specifications that cover the maximum combinations of escape situations is the goal of human factors research in this field.

(For complete papers on which this abridgment is based, write SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ each to members and 60¢ each to nonmembers.)

International Geophysical Year . . .

. . . running from July, 1957, through December, 1958, is the largest cooperative scientific venture ever undertaken. This 18-month period will produce the equivalent of more than 20 years of normal scientific progress.

Based on talk by **Dr. Joseph Kaplan,** University of California at Los Angeles, and Chairman, U. S. National Committee for the IGY

MORE than 5000 scientists from 50 nations will participate in this worldwide program. They will add to the fund of knowledge on the interior, the crust, and the atmosphere of the earth and the sun.

The scientific findings during IGY will affect the lives of millions throughout the world. For instance, solar flares from the sun's surface cause radio communication failures. Learning more about these solar flares will lead to improvements in this area. By probing the earth's atmosphere, we'll know more about what creates our weather.

While the most publicized phase of the IGY program is the U. S. earth satellite project, it's only a small part of the overall program. Projects will be undertaken in 13 scientific disciplines—such as studies on cosmic rays, gravity, the ionosphere, oceanography, and solar activity.

Congress has appropriated $39 million for this country's participation in IGY. The projects being directed by the U. S. Committee for the IGY will involve observation in the United States, Alaska, the waters of the Atlantic and the Pacific, and at Fort Churchill jointly with Canada.

Russia too has extensive plans for IGY. While the Russians have not yet announced their plans, expectations are that they will have a satellite program of their own. The United States and Russia are cooperating. Russia will permit American airplanes to take airplane observations at Murmansk, and land there, while the same privileges will be extended to Russian planes at Fairbanks, Alaska.

(This abridgment is based on a talk entitled "The International Geophysical Year" given at a luncheon held during the SAE National Aeronautic Meeting and Production Forum, Los Angeles, October, 1956.

PRODUCTION NEEDS

. . . are best met when considered early in process of product planning

C. O. Stump, Rohr Aircraft Corp.

Based on the secretary's report of panel "Quality Control and Producibility" which was held as part of the SAE Aircraft Production Forum, Los Angeles, October, 1955.

WITH the advent of modern aircraft and their increasing complexity it is essential that production problems be properly analyzed before the production program starts.

Approaches to Producibility

One approach toward this is to involve Production, Engineering, Tooling, and Inspection in pre-planning.

Working jointly, these groups can:

- Review impractical Engineering,
- Establish a tooling program that will meet the requirements of all groups, and
- Establish practical standards to which the end product must conform.

Thus, the best thinking of each group can be integrated into a program designed to guide subsequent more detailed work.

Another way to coordinate is to establish a Production Engineering Group. Consisting of specialists from the various departments, this group can perform the liaison work necessary before Engineering release. Later, it can correct mistakes that appear on the first units. The Quality Control Group, in this case, would report undesirable conditions to the Production Engineering Group for its action, but would not enter into the pre-planning phases.

After the pre-planning phases, however, Quality Control must cooperate closely in improving producibility. New materials such as titanium, high strength ferrous alloys, 17-7 steel, honeycomb, and so forth, necessitate much closer control of fabricating processes. Control of hot forming procedures, for instance, and of heat treat cycles, of weld procedures and of non-destructive testing of raw materials and finished units are essential to the airplane's structural integrity. . . . And, in many cases, Quality Control has to verify these processes as they are accomplished, since it is impractical to verify accomplishment on the end product.

Participation of Quality Control is needed to help establish:

a. Integration of ideas, at the pre-planning level, on the best methods to meet the cost and quality requirements of the end product.
b. Necessary liaison for the Production, Tooling, or Engineering correction of difficulties in the first stages of production.
c. Control and capabilities of processes important to structural integrity and proper functioning of the end product.
d. Quality standards consistent with processes and with design requirements.
e. Control of materials and fabricated components received from vendors.

Concepts of Interchangeability Needs

Various prime contractors differ, within the limits of MIL-I-8500, on how to verify that interchangeability requirements have been met. But they do agree that these requirements are becoming more difficult to meet.

It is agreed that at the outset of any program Engineering, Tooling, and Production pay too little attention to these requirements. For instance, Engineering drawings not sufficiently specific early in a program lead to later difficulties when the requirements are firmly established. Yet, an analysis group, set up to consider interchangeability, could establish requirements without serious delay in Engineering releases. Such a program would

THE PANEL which lead the discussion at which this article's information was exchanged consisted of:

Panel Leader

I. Dagan, Quality Manager
Rohr Aircraft Corp.

Panel Co-Leader

O. E. Erwin, Chief Inspector
Lockheed Aircraft Corp.

Panel Secretary

C. O. Stump, General Foreman
Rohr Aircraft Corp.

Panel Members

R. H. Gilliland, Manager of Quality Control
Consolidated-Vultee Aircraft Corp.

H. E. Harris, Assistant Director Quality Control
North American Aviation, Inc.

E. W. Makin, Chief Inspector
Douglas Aircraft Co., Inc.

R. R. Thomas, Quality Control Office Staff
Boeing Airplane Co.

materially decrease later tooling and production difficulties.

Few tooling departments have kept pace with modern philosophies. So, they frequently fail to emphasize interchangeability properly. Consequently necessary characteristics may not be designed and built into the tools.

Here again the degree to which Quality Control participates in the producibility of the item varies in different companies. Some companies form groups to consider the interchangeability problem at the Engineering level prior to drawing release. Others let Engineering establish the requirements, with Tooling acting as a filter after the drawings are released. In this case, Quality Control becomes a reporting agency to indicate the degree of conformance.

Quality Control has a definite interest in production tools when these are used as an interchangeability check-off point by inspection. In such cases, the production tools become, in effect, inspection fixtures controlling interchangeability. So, periodic re-check cycles must be established and the tools must be incorporated in the inspection interchangeability procedures.

To verify interchangeability requirements, some contractors establish a fixed cycle for the interchange of components between two or three airplanes. Though technically sound, this procedure leaves some aspects open to question:

1. The "dress rehearsal" approach can make the check of no value.
2. If the interchange is unsuccessful, all units produced after the previous checks are questionable.

A variation of this procedure, with some merit, is to expand the program to include a reinspection of the tools and a re-check of the part to the tool prior to the interchange. This tends to eliminate the "dress rehearsal" problem. (But it does not give complete assurance that all previous parts were acceptable.)

To verify that all units produced are interchangeable, they must be identified either by travelers or notations on the parts, so they can be readily recognized throughout production and final assembly stages. Thus, a continuous surveillance can be maintained during normal installation.

A number of different methods and organizational setups are aimed at attaining conformance to interchangeability requirements. Each has its good and bad points. Any one of them would probably work satisfactorily if the Engineering, Tooling, Production, and Inspection organizations all would actually meet its requirements.

To improve the current status it would seem that:

a. The FIRST release must define engineering requirements more clearly and completely.
b. To resolve the difficulties BEFORE units are in production, liaison between Engineering, Tooling, and Production needs to be earlier and more complete.
c. AT THE EARLIEST POSSIBLE TIME, customer requirements should be more closely analyzed to be sure they are consistent with a producible unit.
d. TOOLING needs to place more emphasis on interchangeable components. Cost considerations frequently result in tools that are incapable of meeting the requirements.
e. Quality Control and Production should CO-OPERATE with Tooling and Engineering AT THE PRE-PLANNING LEVEL. This will familiarize everyone with requirements and insure consideration of everybody's thinking in the final program.
f. The individuals who design, tool, produce and inspect interchangeable components must KNOW the requirements and the importance of meeting them.
g. A CYCLE-CHECK program is necessary to verify interchangeability. Tool reinspections showed argument to cycle-check with the production rate and the tool construction.
h. A SYSTEM OF INSTALLATION SURVEILLANCE is necessary to insure conformance of the units produced between cycle checks.

Machined Aircraft—Challenge to Inspection

It is increasingly tough to maintain adequate Quality Control at acceptable cost levels, because modern aircraft production demands close tolerance in many areas where only sheet metal fabrication tolerances used to be the rule.

To keep pace, for example, subcontractor programs, with their inherent problems of quality and delivery, are being expanded. These involve additional handling and inspection of incoming products . . . and, of course, more inspection cost in equipment, space, and manpower. Also, the size of many components makes necessary large storage

and preparation areas to assure an even flow through the inspection group. In addition, source inspection must be expanded to investigate vendor quality standards and to reduce the amount of discrepant material received at the prime facility. These additional inspection costs cannot be balanced against production cost.

Adequate gaging of this new and complex machining must be carefully considered in relation to tool cost, man hours, and available manpower. The limited number of parts and the limited time available on the first units, compared to the cost and delivery time of complicated check fixtures, points to universal systems and equipment wherever possible. The usual shortage of skilled mechanics, however, means that the systems and equipment must be sufficiently simplified to be consistent with the manpower available.

Due to the cost and complexity of many of the parts, the in-process inspections become more important to the economic use of machine time. Many hours of machine time can be saved by finding defects as they occur and handling them at that point. These in-process inspections can normally be performed on the machine by using the production tool, with a fair degree of accuracy.

This same cost and complexity often makes it advisable for some change by Engineering to produce an equally functional unit at lower cost. This sometimes reduces the complexity enough so less critical machines can be used. Sometimes also, it allows for more flexibility in shop loading—as well as decrease in the skilled labor and equipment requirements for both Production and Quality Control.

In fact, a great many current inspection philosophies in aircraft plants need study and revisions. Some suggestions are:

a. Provide for the increased out-plant activity. (Recognize that inspection costs will rise as the subcontracted work is increased.)

b. Provide a better system for evaluating and selecting vendors so that source and receiving inspections can safely be held to a minimum.

c. Get more emphasis by Tooling and Inspection on devising flexible equipment adaptable to the inspection of fixtures.

d. Revise storage areas, handling areas, inspection areas and equipment to better meet the increasing problem of larger parts.

e. In-process inspection, whether accomplished by Process Control, Inspection, or Production, will play an important part in conserving machine time if properly planned and applied at the right stages.

f. Investigate the possibility of design changes pointed toward decreasing part complexity.

Quality Control plays a definite part in producibility by:

1. Assisting in pre-planning to establish quality standards;

2. Intelligent application of in-process controls . . . both in-plant and at vendor's.

(This article is based on the secretary's report of panel on "Quality Control and Producibility" held as part of the SAE Aircraft Production Forum, Los Angeles, October, 1955. This report together with 14 other panel reports is available as SP-313 from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: $2 to members; $4 to nonmembers.)

In Military Flying Today . . .

. . . the big problem is pilot survival in high-speed, high-performance airplanes.

Based on talk by **Brig.-Gen. Joseph D. Caldara,** USAF, Director of Flight Safety Research, Norton Air Force Base

TAKE the case of two airplanes flying at 600 mph, approaching each other on a collision course. The pilots have no more than 4 sec to see each other and do something about it before their planes meet. If the pilot is in good physical condition (his reactions are quick), and if the plane is functioning properly, he can avoid collision by less than ½ sec. That's because it takes ½ sec to recognize the oncoming plane, 1 sec to decide whether he's coming toward you or going away, and at least 2 sec to actuate the controls to effect the decided maneuver.

Several airplane features are making military flying almost a superhuman chore. For instance, drag parachutes are being used as landing brakes on jets. These are a headache to the pilot and are about as advanced as the sea anchor used by Columbus.

In taking off jet planes, it's imperative that the pilot know not only his speed, but also the distance he has rolled on the runway. On take-off, which phase is responsible for 19% of the accidents, a pilot must try to read markers on the runway to see how far he's gone so he'll know if he can safely abort if necessary. Cars have such instruments. But pilots must still try to read markers they can't see!

Engineers should furnish better latches on such components as landing gear doors, canopies, and access hatches. There's need for a simple latching mechanism to keep things buttoned up.

Engineers should build airplanes for young lieutenants who fly them every day, not for skillful test pilots. These kids deserve a chance to change their minds and make it back to the field without having to push the next-of-kin button and eject themselves.

(This abridgment is based on a talk entitled "Flight Safety and Problems that Can Be Seen for the Future" given at a luncheon held during the SAE National Aeronautic Meeting and Production Forum, Los Angeles, October, 1956.)

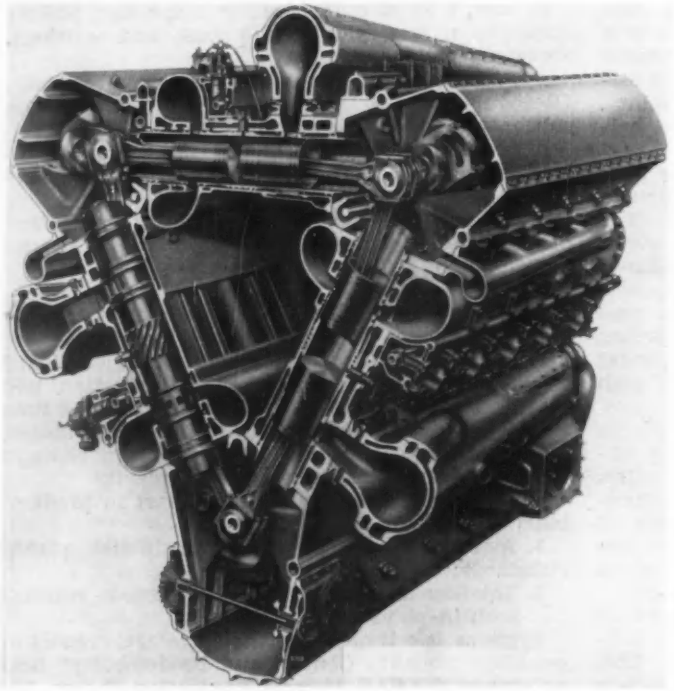


Fig. 1—Cross-section of Napier Deltic diesel engine showing basic design concepts of triangular arrangement with opposed pistons.

Features of Napier

THE Napier Deltic diesel engine combines in a triangular arrangement three opposed-piston engines with a crankshaft common to adjacent engines at each corner. (Design of this engine is shown in Fig. 1.)

Opposed-Piston Principle

The opposed-piston principle has particular attractions for high-speed operation because:

1. Efficient "end to end" scavenging of the cylinder is obtained.
2. Generous port areas and gas-flow passages are possible without undue sacrifice of effective stroke.
3. The complexity and mechanical difficulties connected with the design and operation of valve gear are entirely avoided.
4. There are no cylinder-head sealing problems.
5. The combustion-chamber walls consist to a large extent of hot piston crowns. Heat losses are thereby minimized, and combustion processes are improved with gains resulting in thermal efficiency.

Triangular Cylinder Arrangement

The triangular arrangement, which results from combining three sets of opposed-piston cylinders, brings further advantages:

1. It provides a structure of great inherent rigidity. When care is taken in the design for the transmission of all combustion loads through high-tensile steel bolts, a very robust and light construction results which allows the use of light-alloy castings with no sacrifice in life or reliability as compared to more conventional materials. The basic system of load transmission in the Deltic is illustrated in Fig. 2 which shows that there is direct load transmission from the main bearing caps to the through bolts; hence the cylinder blocks are relieved of all combustion loadings.

The three cylinder blocks are identical light-alloy castings, each held in the assembled engine by steel through-bolts which pass through drillings in the block and clamp it between the two adjacent crankcases. Coolant circulation passages are formed in each casting and are connected to water jackets surrounding the six detachable steel cylinder liners. Triple seal-type rubber rings are provided between liner and block to effect coolant seals.

2. It makes it possible to group multiple cylinders very compactly together, combining the advantages of short length and compactness with low weight per horsepower. The use of multiple cylinders of small dimensions results in a lower weight per horsepower than a smaller number of larger cylinders.

3. It reduces dimensions of the main engine components to the extent that there is the greatest possible latitude in the choice of materials, heat-treatment process, and manufacturing techniques, thus enabling the most modern technical standards to be applied in the design. The components also become suitable for quantity production methods, ensuring complete interchangeability of all parts and low production costs.

Ernest Chatterton, D. Napier & Son, Ltd.

Based on paper "Napier Deltic Diesel Engine" presented at SAE Golden Anniversary Diesel Engine Meeting, St. Louis, November, 1955. This paper is printed in full in 1956 Transactions.

Deltic Diesel Engine

• Opposed-piston principle

• Triangular cylinder arrangement

However, with the triangular formation there are limitations imposed on the designer which arise directly from the geometry of the layout.

First, in order to obtain the correct sequence of cylinder firing it is essential for one crankshaft to run in the reverse sense from the other two. Secondly, a phase difference of 20 deg between the crankshafts at each end of one cylinder is unavoidable.

But neither of these limitations is a disadvantage. The crankshaft rotation can easily be catered for in the gearing arrangements. Some phase difference between crankshafts is essential on the high-speed opposed-piston engine in order to obtain the necessary displacement of the port opening diagrams to give a reasonable exhaust lead angle coupled with a smaller degree of inlet lag for cylinder filling. In the "in-line" opposed-piston engine, it is desirable to reduce this phase difference to a minimum, for as the phase angle is increased, the torque diagrams and the power transmitted through the two crankshafts become widely different and can lead to difficulties in the coupling system between them.

In the case of the Deltic each crankpin carries one inlet piston and one exhaust piston, so that the torque produced and power transmitted at each crankpin are identical. This is a further advantage of the triangular arrangement, and allows the phase angle of 20 deg to be accepted without sacrifice. Resulting design based on this unique arrangement makes for a high-speed, low-specific-weight engine which is compact and light.

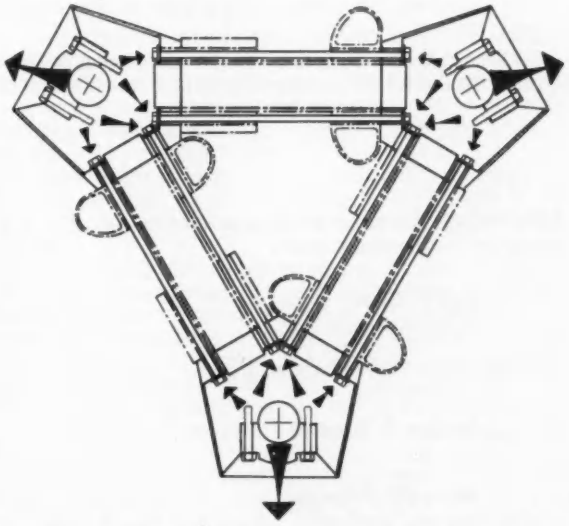


Fig. 2—Diagram showing transmission of combustion loads.

3 Case Histories Point Up

Joseph C. Wellington, Jr., Thompson Products, Inc.

Based on secretary's report of the panel on "Communications" at the 1956 SAE Production Forum, Cleveland, March, 1956.

TO communicate in the factory, management must make clear and keep clear . . .

1. What it wants communicated,
2. From whom and to whom it wants the desired ideas and information communicated; and
3. "Focus" by each communicator as regards his own function and purpose in communicating.

Different techniques are equally successful in getting ideas from one person or group to another. But all of those detailed at this Panel had in common a good, clear pre-focus of purpose and content by the communicator. Where the ideas to be communicated started with management, management had groomed itself for effective communication to start with. Then it took the next step. It set up training procedures to equip its supervisors with a clear knowledge of what it wanted to communicate through them to their subordinates.

Finally, it arranged to train the supervisors to use known techniques to do the actual communicating. The "training" in every case consisted chiefly of helping the supervisor to get across to his people specific, practical ideas management had provided for transmission. The ideas used in training in every instance had meaning and practical substance. No theoretical or completely "dry runs" were made.

Experienced factory executives agreed that "a strong communication link must be established between top management and line supervisors. To make this link a live wire, the supervisor must have clear what his duties and responsibilities are. Otherwise he is communicating with reference to a background that is not parallel to his position."

Ford Methods Cited

To insure this knowledge at Ford in Cleveland, for example, every supervisor and every foreman must undergo six months training. He is told, among other things, that his seven basic responsibilities are: personnel . . . quality . . . cost . . . production . . . use of staff services . . . responsibility for company development . . . materials and techniques. He then goes through a course bearing on

SERVING on the panel which developed the information in this article were:

Emil F. Gibian, chairman
Thompson Products, Inc.

Joseph C. Wellington, Jr., panel secretary
Thompson Products, Inc.

William O. Uraneck
Ford Motor Co.

Henry W. Hopwood
Republic Steel Corp.

Robert R. Tufts
Case Institute of Technology

A. N. Sheahen
Thompson Products, Inc.

Communications

. . . problems and techniques in getting ideas across, to, and through factory supervisors.

each of these responsibilities. . . . He gets 210 hr of training (allocated to each one of the seven areas of responsibility) which Ford considers basic training for line supervisors. About 30% of these courses are classified under personnel and use of staff services—which are very closely related to communications and development of the company. To increase the effectiveness of communications, in other words, Ford believes you must expend a greater amount of time and energy to the subjects which are most closely related to communications.

The Ford program starts with the hypothesis that, if a supervisor is to communicate effectively, he must know what are his own duties and responsibilities toward the company. . . . Only with that as a background can he speak intelligently to anyone who works for him. Then concentration on communications is intensified by having most training relate more closely to communications than to technical problems.

Ford has, in addition, a continued program at college level to which foremen, general foremen, and superintendents are eligible. *All* problems in this advanced program relate directly and importantly to communications:

- Conference leadership
- Speech
- Technical report writing
- Rapid reading

Republic Communicates via Economics

Republic Steel also has found necessary a continuing program of education as a means of establishing satisfactory communications with and by its supervisors. It, too, came early to the conclusion that "there wasn't any sense trying to communicate directly with our 70,000 people . . . that our supervisors were the logical middlemen. We wanted employees to understand the problems the company faced as regards production . . . profits . . . costs . . . the impact of taxes on affairs of the company . . . and the importance of increasing productivity. So, our job was to be sure our supervisors had all the basic economic information they could absorb."

Republic's start toward a solution was a 15-session discussion-group course developed for the company by the University of Chicago. Each session lasted 1½ hr. Sessions were held monthly. Selected supervisors were discussion leaders; each group consisted of 25 or less trainees.

Subjects covered in these original discussions included "A Look at Our Economy," "Managing Your Income," "Understanding Prices," and other similar topics.

Before-and-after questionnaire surveys revealed definite improvement in economic knowledge all along the line. Foreman groups, for example, went from an economic knowledge score of 57.5% before the training to 87% after the training. Union leaders went from 56.5% to 77%.

And there is a final chapter to this Republic story, which an executive who helped to write it tells this way:

"Our production people began to realize that this thing had tremendous impact as a means to get our foremen working with us. We had one case where the quality of our product was giving us some trouble. We were getting more complaints than we should have.

"The vice-president in charge of operations called us in and said: 'Look, you guys purport to know

something about this matter of communications and how to get ideas across. Let's see you get this quality idea across. Let's see you go out and earn your keep for a change! Never mind these high-sounding theories about economics!'

"Well, we were able to do it. The University of Chicago developed for us a very good session on quality. The whole training procedure was exactly the same as that already described. The discussion leaders were called in from Chicago, given the session on quality, went back to their plants, put it on for all supervision over a period of about six months. Then, in turn, the discussion material went down through the supervisors to the working force.

"Our claims dropped by better than 50% inside of three months."

High Level Blocks Removed

The experience of a large storage battery company furnishes a good example of how still different techniques successfully solved still another type of intra-company communication difficulties. The problem was absence of effective exchange between levels of management as well as between the different operating staff functions.

The basic structure of the organization consisted of a president and four vice-presidents . . . one each for finance, engineering, manufacturing, and sales. These five men became an advisory and guiding committee for the communications program.

The total group of 80 (including the four vice-presidents) was divided into four parts for conference work purposes. No manager and his immediate boss were in the same group—to insure freedom from any restraints to free discussion. Two selected members of each group were trained—in a thorough course—to be conference leaders.

The guiding committee—with the president as chairman—laid out as many actual operating and staff problems or pressure points as they could conceive. Then, each of the four conference groups did the same thing.

The information drawn from each of the four groups turned out to be essentially the same. At least, any member of one group, seeing the summary notes, concluded they represented the results of his particular group meeting. Attached to the summary report was the action taken by management on those problems which could be resolved. (This was essential to show all members of all groups that this was an action program—not playing with paper dolls.)

These four groups were advisory in their status. Many of the problems for which solutions were sought were handled through normal organization lines.

After two years, or 20 meetings, an individual counseling program was initiated to train individually the lowest level supervisors in this group to communicate effectively with their immediate subordinates. Later, this training was projected to the first line supervision by group-training techniques. This completed the chain of communication . . . and set up a two-way system embracing all employees.

The success of this program is attested by the fact that it never went stale. It became an integral part of the management pattern of activity. It was self-perpetuating in context to the tremendous advantage of the management team as a group.

Varied Problems Faced

The most effective form of communication, executives seem to agree, is that which occurs directly between one man and another. But, industrial organization in general doesn't lend itself to this type extensively. The chief problems usually occur—as in the case histories cited—in communications between a man and a group . . . or between two or more groups.

(The report on which this article is based is available in full, together with reports of six other panel sessions of the SAE National Production Forum held in Cleveland, March, 1956. This publication, SP-314, is available from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: $1.50 to members; $3.00 to nonmembers.)

Rules of Thumb from Quality Control Notebooks

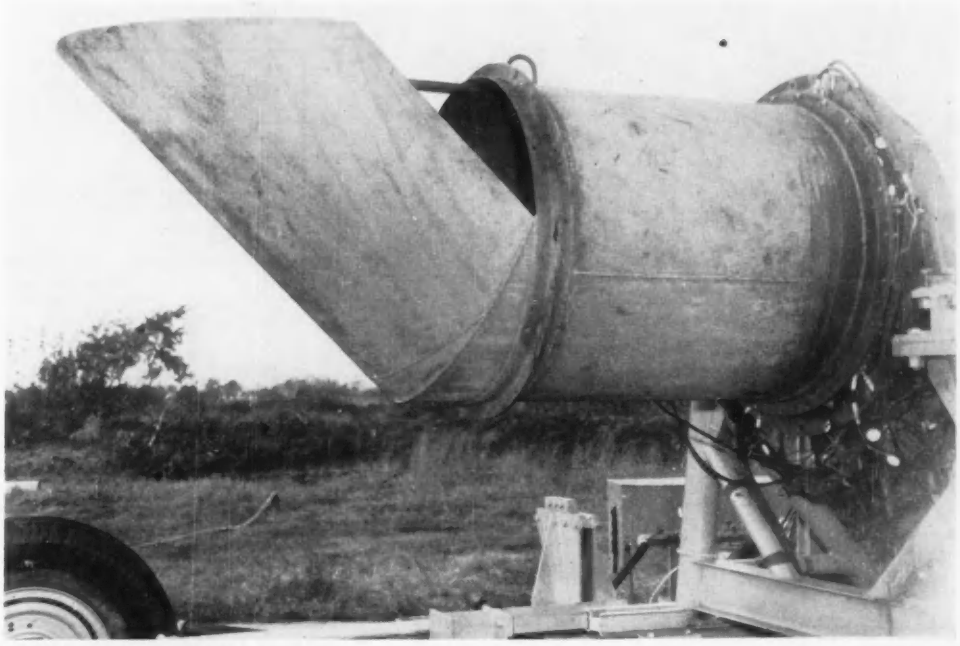
■ *Broadly speaking, when 5% of the product sold fails to perform satisfactorily on a unit or a dollar basis, the point has been reached where the manufacturer is no longer competitive.*

■ *When there is a difference of opinion between manufacturing and the field as to what the quality level should be, the engineering department should act as arbiter for the final decision.*

■ *The time to establish relative quality importance is on the drawing board. After the design is set, inspection should adhere strictly to specifications.*

■ *A machine should be capable of producing a part to 75% of the total tolerance on the dimension to be held, if blueprint specifications are to be met.*

—Statements made in open discussion at
SAE Production Forum, Cleveland, March, 1956



INLET NOISE REFLECTOR directs sound from jet engine compressor upward away from ears of workmen during ground testing. Reflector as shown causes pressure losses at the top of the inlet. But addition of a bellmouth to the half of the cylinder not attached to the scoop reduces these losses and gives average pressure losses across the face of the compressor approximating those obtained without the reflector.

For Jet Engines, P & W A Devises an

Inlet Noise Reflector

J. M. Tyler and R. Krieghoff, Pratt & Whitney Aircraft

Based on paper "Suppression of Jet Engine Noise During Ground Running" presented at SAE National Aeronautic Meeting, New York, April, 1956.

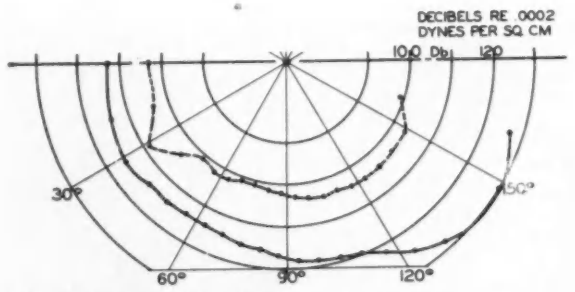
PRATT & Whitney Aircraft has devised a portable inlet noise reflector for use during the ground testing of jet engines outside test cells. The reflector reduces overall noise ahead of the engine by 7 to 13 db.

The reflector directs inlet noise upward, away from the ears of ground personnel working nearby and neighbors. The noise is caused by the compressor blades cutting through the air which flows between the inlet guide vanes in the compressor. Inlet noise becomes predominant in ground testing where exhaust noise suppressors reduce the noise from that source by 30 db or so.

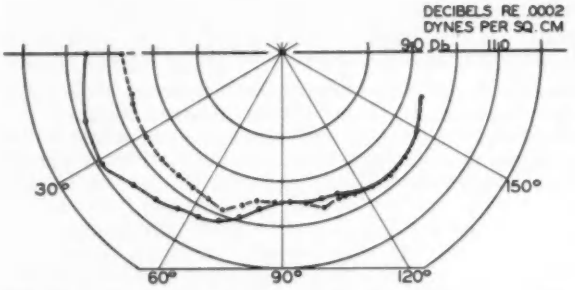
The inlet noise of the Pratt & Whitney J57 comes primarily from the first three stages of the compressor. Outstanding component at most operating conditions is the fundamental of the first stage. At maximum rotor speed its frequency is about 2500 cps.

The engine air inlet beams this relatively high frequency noise forward. The reflector sends it upward. The plot of the octane band spectrum shows how the device reflects not only the fundamental of the first stage but those of the other stages and their harmonics.

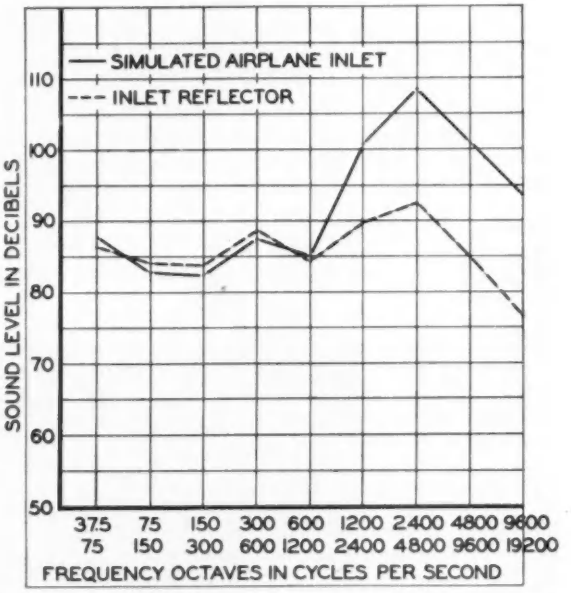
The reflector does, of course, affect the airflow to the engine to some extent. But with a bellmouth section attached to the exposed half circle at the top of the entrance a scale model reflector approximated the *average* inlet pressure losses without the reflec-



WITH INLET REFLECTOR and exhaust noise suppressor (dotted line) noise is 10 db or so less at front of engine than with exhaust suppressor only. This pattern of overall noise was measured for J57 operating at 8150 lb equivalent thrust. Measurements were made on an arc of 150 ft radius centered at the engine exhaust nozzle; 0 deg is on engine centerline, in the forward direction.

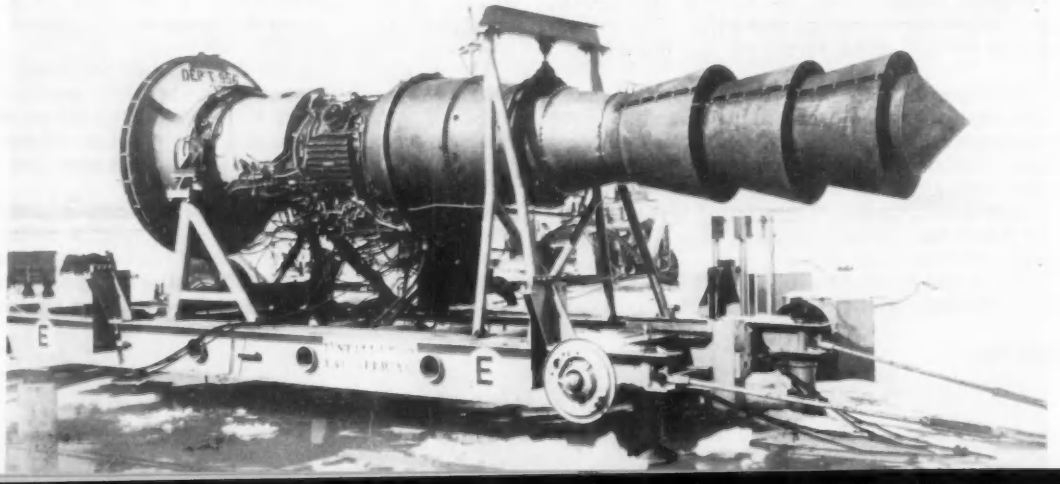


EXHAUST NOISE SUPPRESSOR ALONE (dashed line) on J57 operating at 10,000 lb static thrust cuts overall noise markedly from conditions with no silencing (solid line), especially toward rear of jet, where exhaust is noisiest. (Addition of inlet noise reflector would bring noise levels still lower.) Exhaust noise suppressor is shown in photograph below.



NOISE SPECTRA with inlet reflector (dashed line) and with a simulated podded airplane inlet show that reflector is very effective in the 2400-4800 cps range, which includes the fundamental noise frequency of the first compressor stage. Even more than it is apparent from these octane band data, it is apparent to the ears of people on the ground that the discrete frequencies beamed out through the compressor inlet are greatly reduced at ear level by being reflected upward. Measurements were taken 150 ft from the exit of the exhaust nozzle at an angle of 32 deg from the front of the engine, a direction in which noise is a maximum when the engine is run without the reflector. Exhaust noise suppressor was on the engine.

EXHAUST NOISE SUPPRESSOR shown mounted on J57 turbojet engine has perforated cylinder surrounded by three conical shrouds, and a perforated cone at its end. The perforations break up the jet into smaller streams, thereby raising the frequency of the noise associated with the jets of the resulting frequencies. The very high pitched ones are inaudible and the high audible frequencies are more subject to natural attenuation than the frequencies otherwise associated with the jet exhaust. The shrouds direct the exhaust aft, to prevent recirculation to the inlet or overheating of the wings of aircraft above and aft of podded engines. The suppressor has no significant effect on engine operation.



tor for a pod type installation. It did not however duplicate the pressure pattern existing in normal pod type installations.

The inlet noise reflector used with an exhaust noise suppressor reduces overall noise levels to the point where the risk of damage to the hearing of mechanics working on the operating engine is practically eliminated. This assumes, of course, that workmen wear good ear protectors and are exposed to the noise for only short periods.

Both the inlet noise reflector and the exhaust noise suppressor are so easy to install and remove that there's little temptation to run without them. Both devices can be taken to the test area, snapped into place on the engine—either in an airplane or on a ground test stand—and the engine started running. When ground running is completed, they can be removed from the engine quickly, and if the engine is installed in an airplane, the airplane is ready to taxi away once the engines are restarted.

(For complete paper in multilith form on which this abridgment is based, write SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Jet Noise Suppression . . .

. . . can best be accomplished by combinations of three fundamental methods.

Excerpts from paper by **M. M. Miller,** Douglas Aircraft Co., Inc.

INCREASED noise suppression can be obtained by combinations of the three fundamental methods of suppressing the irritating properties of normal jet noise. They are to:

1. Shift frequencies: This method was first proposed by Pratt & Whitney Aircraft. It utilizes the fact that the predominant sound energy produced by a jet shifts to higher frequencies as the dimensions of the jet are reduced. The resulting increased effective noise reduction occurs because of the greater loss of high-frequency sound energy in passing through the atmosphere; the frequency shift also takes advantage of the decrease in sensitivity of the human ear at frequencies above 4000 cps.

2. Alter jet mixing: Researchers at the University of Southampton College of Aeronautics and Engineers at Rolls-Royce found that devices attached at the jet-engine nozzle to encourage rapid early mixing of the jet stream with the outside air also caused an appreciable noise reduction; the frequency at which the greatest reduction occurs can be governed by the geometry of the mixer.

3. Reduce velocities: This principle was evident as soon as it was shown that the noise of a jet was proportional to a very high power of the jet exhaust velocity (ρAV^{8}*). When the jet velocity can be reduced and the thrust maintained by increasing the density of the exhaust gases or the area of the exhaust, a substantial noise decrease is accomplished.

An extreme form of the frequency shift is represented by the long tail pipe developed by Pratt & Whitney, which contains many thousands of small holes. In this form, it is difficult to visualize the device as a practical flight suppressor, although it has been developed into an economical and efficient ground suppressor.

The original form of the jet mixing devices was presented by Rolls-Royce as the well-known corrugated nozzle. Such a device accomplishes a worthwhile noise reduction but will have to be developed further so as not to penalize thrust performance at cruise conditions.

The bypass engine is a form of velocity-reducing device, but the engine would have to be inordinately large if it supplied enough cold secondary air (to change ρAV^{8} enough) to obtain the desired noise reduction. The ejector is another form of velocity-reducing device, but when used with the plain conical jet nozzle it may have to be extremely long to mix the jet and induced air properly in order to provide the required ρAV^{8} change at the ejector exit.

To my knowledge, only pairs of suppression elements have been combined at the present time, but I believe that the best noise suppressor may result from an optimum combination of all three principles or some new principle yet to be discovered.

This abridgment is based on paper "Sound and Furor—The Jet Noise Suppression Age" presented at the SAE National Aeronautic Meeting, Los Angeles, October, 1956. For complete paper (in multilith form) write SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.

* Where ρ = jet exhaust gas density, A = jet exhaust area, and V = relative velocity of exhaust gases and outside airstream.

Both military and civilian operations in extremely frigid areas such as Alaska, Canada, Greenland, and Antarctica require equipment which can be operated at temperatures as low as -65 F. SAE and the U. S. Army Corps of Engineers are jointly conducting cold weather tests to find out . . .

How to Winterize Construction

The Authors

THIS ARTICLE is based on several papers by the following members and consultants of the CIMTC Subcommittee XV Winterization and the ERDL Winterization Section:

M. G. Mardoian
International Harvester Co.

F. M. Baumgardner
Engineer Research and Development Laboratories

T. H. Fones
Caterpillar Tractor Co.

W. W. Cornman
Allis-Chalmers Mfg. Co.

A. Q. Spitler
Engineer Research and Development Laboratories

P. W. Espenschade
Engineer Research and Development Laboratories

J. A. Klisch
Engineer Research and Development Laboratories

Papers were given as a Symposium—**Winterization of Construction Equipment**—at the SAE National Tractor Meeting, Milwaukee, Sept., 1956.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: $1 to members; $2 to nonmembers.)

LAST winter on the biting cold Mesabi Iron Range in northern Minnesota, three crawler tractors and one motor grader were put through their paces to find out if standard equipment could be winterized to operate efficiently in cold, snowy weather.

In general the modifications by the manufacturers—who each took a slightly different approach to winterization design—were satisfactory. The tests showed, however, there was room for improvement and that further research and development in the field and in laboratory cold rooms were necessary. This winter more equipment, modified according to last year's findings, is being tested in Alaska.

Standard Equipment Was Modified

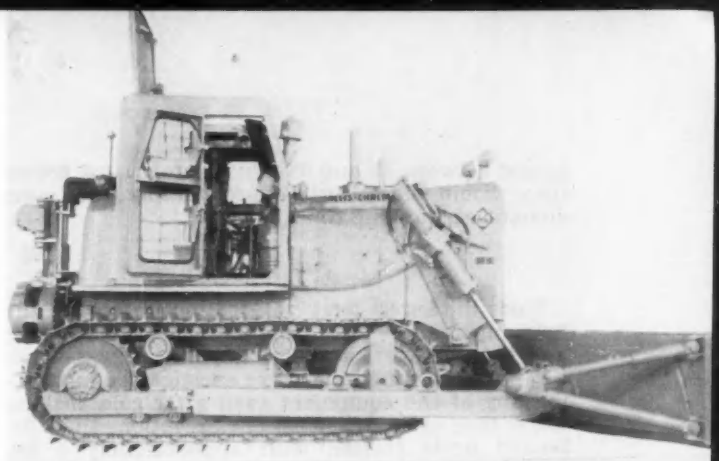
Four manufacturers provided winterized equipment for the 1955–56 tests:

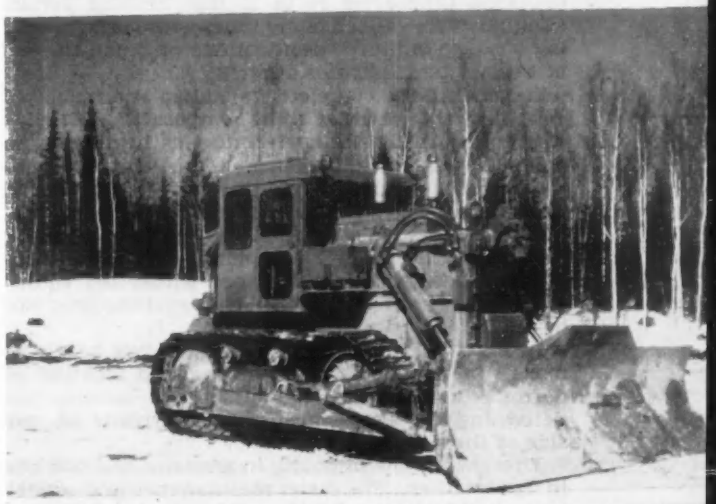
1. Austin-Western Works, a Division of the Baldwin-Lima-Hamilton Corp., provided a standard model 99L motor grader.
2. International Harvester Co. provided a TD-18, series 182, diesel crawler tractor.
3. Caterpillar Tractor Co. provided a standard D7 tractor.
4. Allis-Chalmers Mfg. Co. provided an HD-16A crawler tractor.

Each manufacturer was given pretty much a free hand to winterize his standard model as he thought best. Each was asked to:

1. Provide an insulated engine enclosure that would prevent snow and ice from clogging the mechanical controls and accessories.

Top to bottom:
Allis-Chalmers
International Harvester
Caterpillar
Austin-Western





Equipment

2. Provide a heating system to warm the engine and batteries prior to starting.

3. Provide a heated cab and adequate window defrosting devices.

4. Provide an escape hatch in the top of the cab so that the driver could escape immediately if the vehicle fell through river ice.

5. Provide controls that were accessible and easy to operate by personnel encumbered with bulky clothing.

6. Provide "slave" electrical receptacles conforming to MIL-C-13993C and cables adequate for external engine cranking in emergencies.

7. Provide hose and fabrics (wherever possible) that could be used between – 65 F and + 125 F and could be stored for some time at – 80 F.

8. Provide drive belts that conformed to MIL-B-11040, Type I or II, Class A.

9. Provide 24 v lighting systems.

10. Service the equipment with arctic military fuels, lubricants, hydraulic fluids, and antifreeze.

Detailed descriptions of each manufacturer's winterized vehicle are given on the accompanying pages.

Cold Chamber Tests

Prior to being sent to the Mesabi test site, the vehicles were tested in laboratory cold chambers at – 25 F and – 65 F. At – 25 F the engines started after 7 to 30 sec cranking. At – 65 F the engines re-

quired between 47 and 68 min of preheating before they would start with approximately the same amount of cranking time.

Mesabi Test Results

Since the lowest temperatures encountered in the field during these tests were between – 20 and – 25 F and the average low daily temperature was about 0 F, no major difficulties were encountered in starting any of the equipment even after cold soaking for as long as 48 hr. With few exceptions the winterized units started with approximately 3 sec cranking time after 10 to 15 min heating period. (Engines were started many times without any heating because military specifications preclude the use of heat at temperatures above 25 F.)

In general, the completely enclosed and insulated cabs were too warm at these temperatures. Heavy clothing worn by the operators, plus heat radiated from the engine and transmission, kept the cabs warm without the use of cab heaters. (The cab heater in the grader was used often because very little heat was received from the engine and transmission.) The CIMTC Subcommittee XV (Winterization) has recommended that winterized equipment have heating and ventilation systems that can be regulated easily by the operator.

In all cabs there was excessive window breakage due to improper design mounting and location of defroster ducts. The windows broke because hot defrosting air was concentrated narrowly at one side of the window.

There was some difficulty in servicing the tractors in bad weather. For easier maintenance and service accessibility during frigid weather more quick-disconnect fitting for plumbing and electrical circuits are recommended. Hinged connections and a few large snap or pull-down latches or hasps are better than bolts and screws in covers and panels that are frequently removed.

The most frequent trouble with the heaters was igniter failure due to excessive on-off cycling of the heaters. Heaters stopped when fuel was used up or ice was formed in the heater fuel lines. Locating the fuel gage and warning light where the operator can see them easily will enable him to be aware of trouble and correct it before the heater starts cycling on and off. It is recommended that high mortality parts such as igniters be made more mechanically and electrically durable and be designed for more easy replacement or adjustment.

Although torch type heaters were effective in preheating engines they were also dangerous. It is recommended that they be made safer and easier to ignite and control.

Although the hot air ducts distributed heat well, in some cases they obstructed vision. It is recommended that heat and ventilator air intakes and exhaust be designed better to prevent being clogged with snow and ice.

Hydraulic cranking systems motors and accumulators operated satisfactorily. Due to poorly designed linkage, however, some difficulties developed in the cranking motor engaging device.

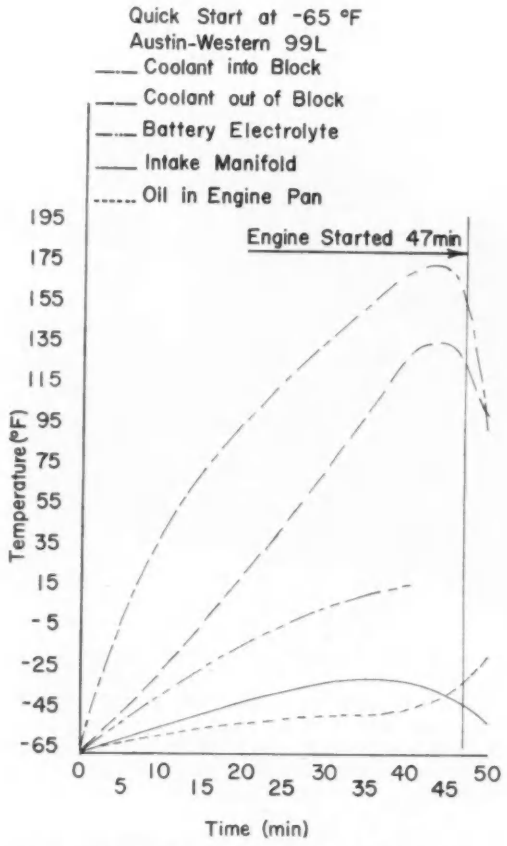
A set of nickel cadmium batteries, which were supposed to be comparable to lead-acid types, did not measure up to expectations at sub-zero temperatures.

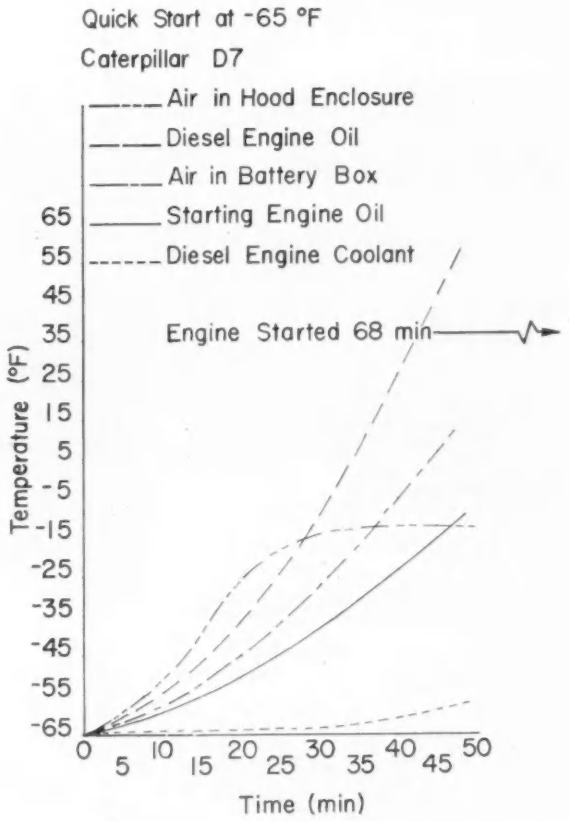
Sliding plate winterfronts on all but one unit and mastic thermal insulation were mechanically satisfactory and durable. Sheet ensolite floor mat was not. Glass wool sheet insulation in battery boxes also showed signs of disintegration and separation.

Program Will Continue

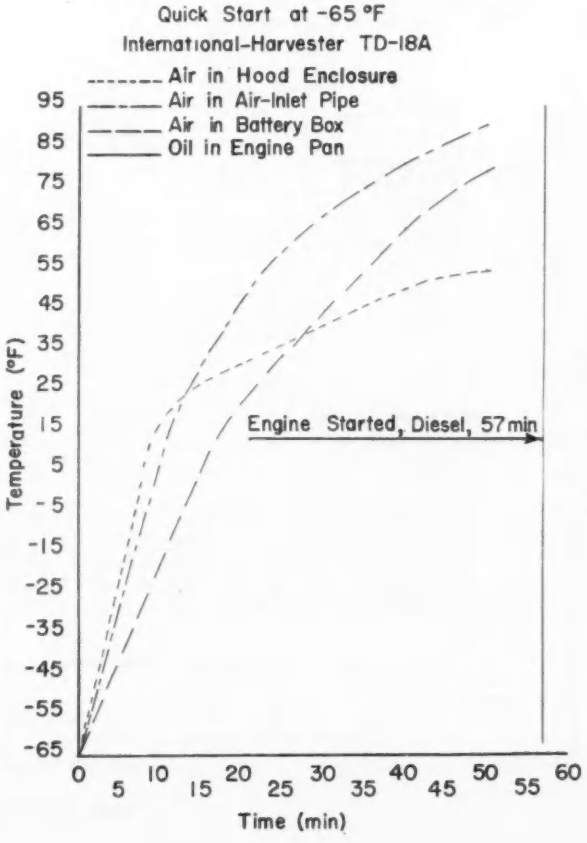
The generally good results of the winterized equipment is not leading the Corps of Engineers nor SAE CIMTC Subcommittee XV (Winterization) into a false sense of complacency. Laboratory and field tests are continuing this year and recommendations to manufacturers are being made to improve equipment for use in cold weather.

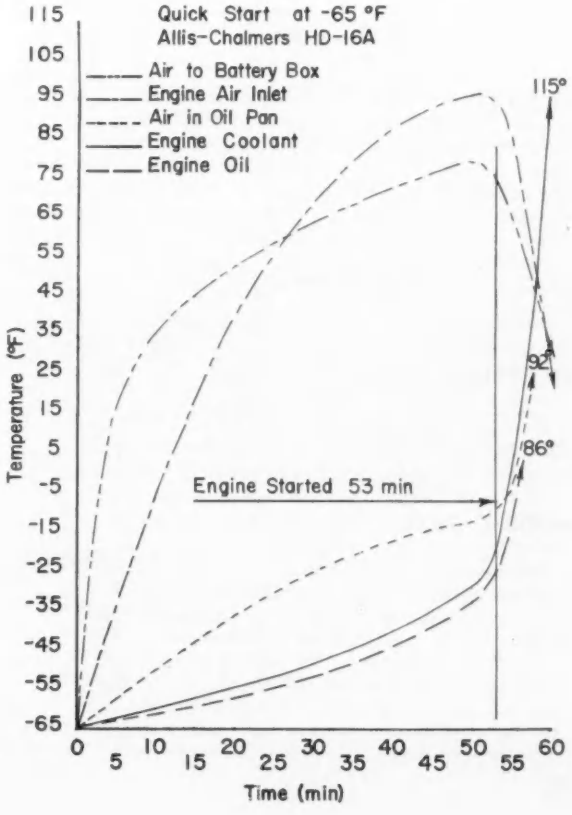
THIS PICTURE was taken when some of the members of Sub-Committee XV Winterization met at the test site in Aurora, Minn., on Jan. 24 and 25, 1956, to inspect the winterized tractors and motor grader.



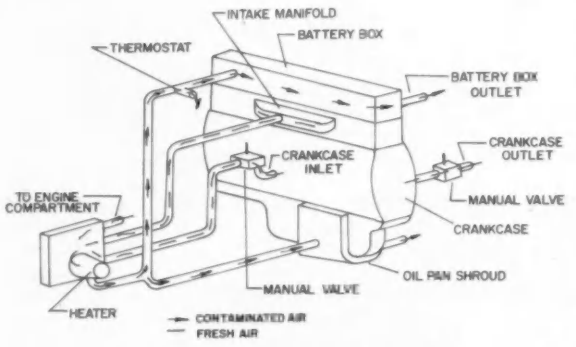


STARTING TIMES of the four winterized units in a cold room at –65 F. Warming, priming and starting procedures were those recommended by the manufacturers.





Winterized International TD-18 Series 182 Tractor



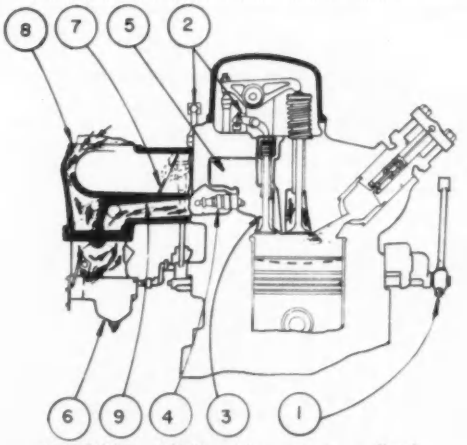
POWERPLANT HEATING: A Perfection E-510 fresh air heater using gasoline fuel provides 60,000 Btu per hr of fresh air and 30,000 Btu per hr of contaminated exhaust gases. Fresh hot air is ducted to the engine compartment, the intake manifold shroud, and into the crankcase to warm the engine internally. Half of the heater contaminated gases is used to heat the batteries; the remainder is directed to the oil pan.

ELECTRICAL SYSTEM: Two 12 v, 8T arctic-type batteries mounted in series.

CRANKING SYSTEM: Electric motor (24 v) with manually engaged overunning clutch drive.

MODIFICATIONS: Since the Mesabi tests, International Harvester has widened the cab, improved operator visibility, reversed the tilt of the front windows, installed the engine muffler under the hood, relocated the engine and personnel heaters so that accessibility to the engine compartment is improved. The heating system has been redesigned, the battery box moved to the cab, the defrosting system changed and a new seal material for the cab door has been provided.

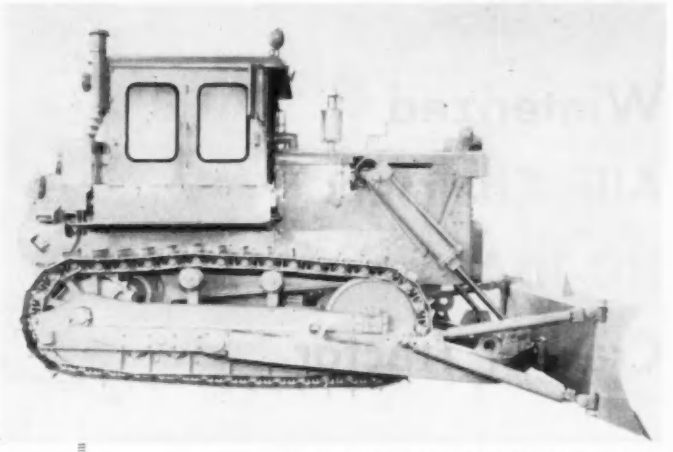
CAB DESIGN: Safety glass windows are tinted to reduce sun glare. Rear windows can be slid open. Insulated with mastic and mesh granulated cork. Escape hatch in roof is large enough for two men. Panic bar unlocks hatch. Another Perfection E-510 heater provides cab heat and defrosts cab windows.



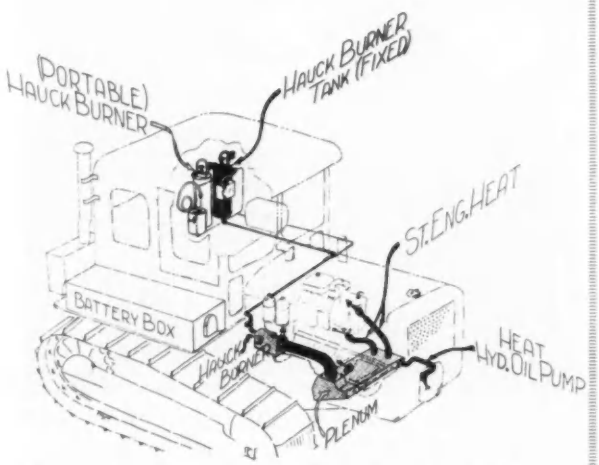
PRIMING AIDS: No priming fluids needed because it uses a gasoline starting system integral with the engine. Gasoline is ignited in an auxiliary combustion chamber by spark plugs. After one to four minutes operation on gasoline, the operator switches to diesel fuel and cuts off the gasoline combustion chambers from the diesel combustion chambers.

1. Cycle changeover lever
2. Starting valve linkage
3. Starting valve
4. Spark plug
5. Auxiliary combustion chamber
6. Carburetor
7. Butterfly valve
8. Intake manifold
9. Gasoline cyle air passage

Winterized Caterpillar D7 Tractor



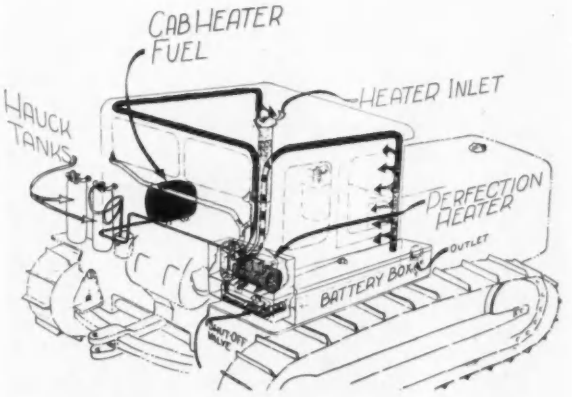
CATERPILLAR D7 TRACTOR is rated at 102 draw bar horsepower. Fully winterized tractor with hydraulic dozer and rear mounted cable unit weighs 40,000 lb.



POWERPLANT HEATING: A Hauck 251, 265,000 Btu per hr gasoline burner provides heat to engine enclosure. Auxiliary Hauck 251 burner and storage tank on left rear fender provides a portable heating source to remove heavy ice and snow. Open pan of gasoline used to preheat vaporizing coils.

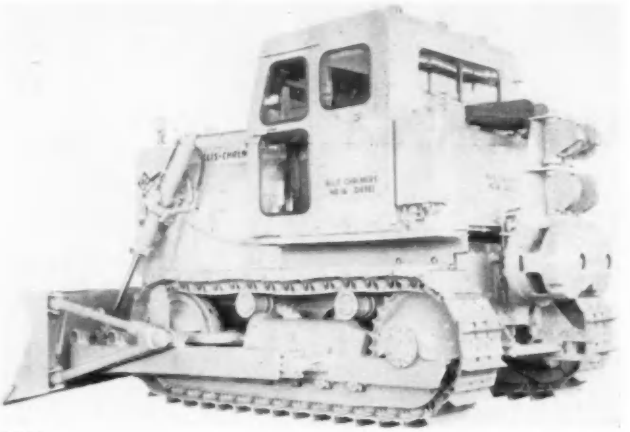
ELECTRICAL SYSTEM: A 24 v cranking motor starts the gasoline starting motor. Shielded 24 v- 40 amp charging generator and regulator. Shielded starting engine magneto, spark plugs, and cables.

PRIMING AND CRANKING SYSTEM: Conventional 2-cylinder vertical starting engine equipped with 24 v starting system. Chevron pressurized capsules are used to aid starting below -25 F.

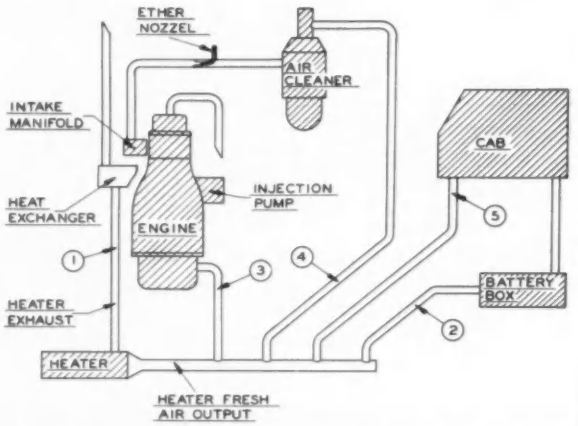


CAB DESIGN: Standard Crenlo cab is insulated with ¼ in. Ensolite. Floor matting is ½-in. Ensolite. Roof is insulated by glass fiber and thin, perforated steel plate. Escape hatch in roof has escape bar with mechanical advantage needed to break ice and snow seal. Cab is heated with an E-500 Perfection fresh air heater, giving 30,000 Btu per hr on high and 15,000 Btu per hr on low.

Winterized Allis-Chalmers HD-16A Crawler Tractor



ALLIS-CHALMERS HD-16A crawler tractor weighs 41,500 lb completely winterized. Uses 844 cu in., naturally aspirated, 4-cycle diesel engine.

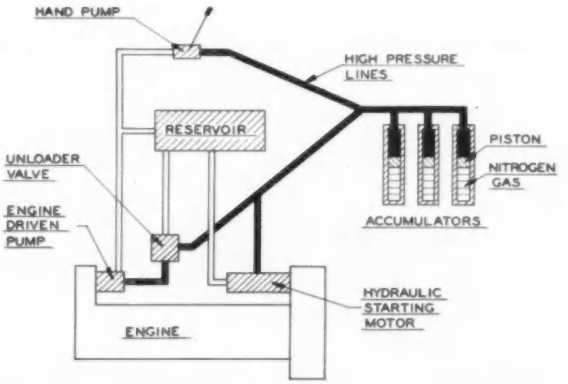


POWERPLANT HEATING: A perfection E-510 fresh air heater provides 60,000 Btu per hr fresh air and 30,000 Btu per hr in the contaminated exhaust. Half of the fresh air is carried to the battery box. Half of the heater fresh air output can be used at the operator's option to heat the cab, defrost windows, heat the engine air intake system during starting, and heat the engine internally prior to starting.

CAB DESIGN: Standard cab has permalastic insulation, defroster system, and two-man escape hatch in the roof.

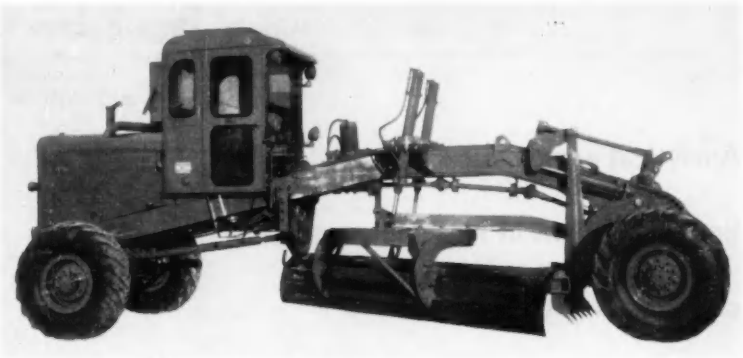
ELECTRICAL SYSTEM: Sintered-plate, nickel-cadmium batteries were used to operate engine heater and lights. Alternate electric starting motor is provided.

PRIMING AIDS: Ampco-Sinclair bulk ether applicator provides 100 cc's of pressurized ether at time of starting. Additional 190 cc of ether are available if needed.

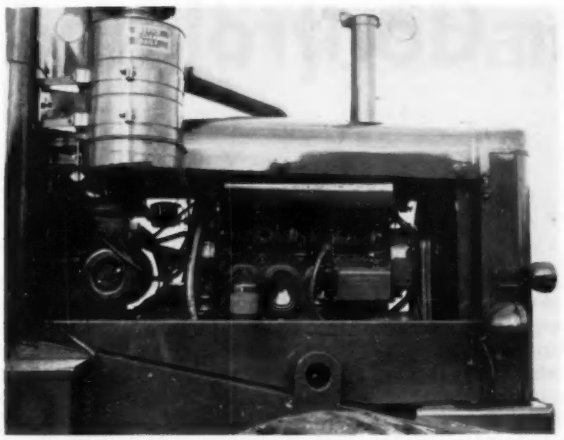


CRANKING SYSTEM: Hydraulic cranking system provides high initial cranking torque and speed.

Winterized Austin-Western Motor Grader



CAB DESIGN: Cab is insulated with glass fiber and perforated metal sheets which reduces heat loss and sound. Floor is covered with a sponge-type material called Ensolite. Escape hatch in top of cab. Window is made of tinted safety glass. Cab is heated by a Perfection E-500, 24 v, gasoline burning fresh air heater. Heater controls are in the cab.



POWERPLANT HEATING: Gasoline burning, thermostatically controlled, Perfection E-511 coolant heater. Output rating is 60,000 Btu to the coolant and 30,000 Btu to the contaminated air. Heated coolant is pumped through the engine block and through a heat exchanger that is in the oil pan.

PRIMING AIDS: GMC bulk type ether container. Ether fluid is injected into the air intake chamber by manually controlled primer located inside the cab.

CRANKING SYSTEM: Electric starting motor (24 v) with manually engaged drive.

ELECTRICAL SYSTEM: Four 6 V, 4H, 150 amp-hr batteries. Heated by air drawn from cab heater.

MODIFICATIONS: Since the Mesabi Iron Range tests, this grader has been modified. Major improvements include among others, a sturdier winterfront and a new escape hatch mechanism.

Analytical examination via

linear equations of motion

casts new light on . . .

Car Control and

USING linear equations of motion, factors governing vehicle stability and control can be examined analytically without resorting to actual numerical solutions.

- The steady state response can be expressed as a linear function of the tire, roll steer, and roll stiffness properties of the car;
- The dynamic or transient behavior in a free oscillation is completely described by the characteristic equation obtained from the three lateral equations of motion.

The static or steady state yawing moment acting on a car during a steady turn is interesting to examine first. Fig. 1 shows the forces and moments on a car which are produced by front wheel steer angle, angular yaw velocity, and lateral velocity respectively. (For simplicity, aligning torques and forces caused by vehicle roll are not shown.)

The (a) diagram in Fig. 1 shows that a positive steer angle produces a better positive side force at the front wheels . . . and thus a clockwise or positive yawing moment on the vehicle equal to the total front wheel side force times the distance between the front wheel center and the vehicle center of gravity.

The (b) diagram in Fig. 1 shows that a positive yawing velocity induces slip angles at the front and rear tires such that the front tires produce a force to the left—and the rear tires a force to the right. . . . These tire forces produce a negative yawing moment which opposes the yawing moment of the car. A moment opposing the angular velocity is a damping moment. So, the yawing moment due to the yawing velocity is termed the "damping in yaw."

Finally, in the (c) diagram of Fig. 1, it appears that a vehicle which has positive lateral velocity along its y axis or which is sideslipping to the right is subjected to tire side force, front and rear, acting to the left. . . . The resultant yawing moment is dependent on the center of gravity (cg) location and the relative magnitude of the front and rear cornering powers. Forward cg locations and rear cornering power higher than front cornering power result in a positive yawing moment for a positive angle of sideslip. The reverse is true for rearward cg locations and low values of rear cornering power relative to front cornering power.

Diagram (c) indicates also that a clockwise or positive yawing moment produced by positive sideslip tends to align the vehicle with its direction of motion or to reduce the angle of sideslip. Such a vehicle is defined as being attitude or directionally unstable.

This stability is identical to the weathercocking stability of a weathervane—or the directional stability provided by the vertical tail on an airplane. On a four-wheeled vehicle, the rear tires provide a stabilizing moment; the front tires, a destabilizing moment. (The attitude stability is merely a property of a vehicle which is sideslipping. It does not say anything about the overall stability of the car.)

Moment Equilibrium

Let us now examine the moment equilibrium during a steady turn in which the steer angle is held fixed, and the car possesses a constant yawing velocity and angle of sideslip. Since the moment due to sideslip is small and may be zero, it is the steering moment which primarily balances the yaw damping moment. Thus, in a right turn, the positive steering or control moment overcomes the negative "damping in yaw" moment.

If the moment due to sideslip be assumed zero, the yawing velocity per unit steer angle is equal to the forward velocity divided by the wheelbase.

Leonard Segel, Cornell Aeronautical Laboratory, Inc.

Excerpts from paper "Research in the Fundamentals of Automobile Control and Stability" presented at SAE Summer Meeting, Atlantic City, June, 1956.

Stability Characteristics

This is another way of saying that the steering angle in a steady turn is equal to the wheelbase divided by the radius of the turn, the so-called Ackerman angle. A steady state yawing velocity response equal to the forward velocity divided by the wheelbase is the basic response characteristic of the automobile and is modified only by the existence of the vehicle's directional stability properties. This conclusion is deduced from examining the moment balance in a steady turn.

It may also be shown that the yawing velocity response per unit steer angle is modified by moments which are a function of the roll angle of the vehicle. These may be positive or negative and either increase or decrease the moment tending to align the vehicle with its direction of motion. Moments due to roll angle, therefore, contribute to the total directional stability or instability of the vehicle.

Since the moment due to sideslip can be altered by shifting the cg fore and aft, it becomes convenient to describe the total directional stability in terms of an effective moment arm in percent of the wheelbase. This effective moment arm has been termed the "static margin" of the vehicle.

Relating "over and understeer" to the static margin is a means of numerically defining the total directional stability of a vehicle. (Maurice Olley has defined "understeer and oversteer" in terms of the path or course pursued by a straight running vehicle when subjected to a steady side load applied at the center of gravity.)

On defining front and rear sideslip angles as the angle between the longitudinal axis of the car and the velocity vectors of the front and rear axle centers, it is seen that the path of the car is determined by these steady state sideslip angles.

If an applied side load produces equal front and

Aero Research Contributes To Automobile Handling Studies

This article explains certain basic steady state and dynamic properties of car "handling" by use of a theory—the development of which the author describes in the paper from which these excerpts were taken.

The paper, "Research in the Fundamentals of Automobile Control and Stability," tells the story of accomplishments to date in a research program which resulted from recognition that the know-how obtained from research in aircraft stability and control could be applied directly to the automotive "handling" problem.

Scientific determinations are equally necessary, the author feels, to answer the question: "What does the driver want and need in the way of handling qualities?"

"This corollary question," he says, "is now being actively investigated in the aeronautical field, and application of this experience to automotive research would go a long way in helping to solve the complete problem of automobile handling."

★ ★ ★

(For complete paper from which these excerpts were taken, write SAE Special Publications, 485 Lexington Ave., New York 17, N.Y. Price: 35¢ to members; 60¢ to nonmembers.)

rear sideslip angles, the vehicle moves off on a new straight line path. A rear sideslip angle greater than the front sideslip angle will result in a curved path toward the applied load, and front sideslip angle greater than rear sideslip angle will result in a curved path away from the applied load. The terms "neutral steer," "oversteer," and "understeer" were applied to these three path configurations, in the order named, as indicated in Fig. 2.

Following is the meaning of the symbols used in Figs. 1, 2, and 5 in this article:

a Distance between vehicle center of gravity and front wheel center, ft

b Distance between vehicle center of gravity and rear wheel center, ft

x, y, z Body axes fixed in vehicle

ϕ Roll angle of the vehicle, deg or rad

δ Steer angle of front wheels, deg or rad

V Forward velocity of the vehicle, fps

v Lateral velocity along y axis, fps

r Yawing velocity around z axis, rad per sec

Y Force along y axis, lb

$\varepsilon_2 = \partial\delta_2/\partial\phi$, rear roll steer, rad/rad

α_1 Slip angle of front tires, rad

α_2 Slip angle of rear tires, rad

β v/V, Sideslip angle of vehicle

In terms of yawing velocity Fig. 2 may be interpreted as follows:

- When the vehicle is NEUTRAL STEER, a side load applied at the cg produces zero yawing velocity.
- When the vehicle is UNDERSTEER, a positive side load produces a positive yawing velocity.
- When the vehicle is OVERSTEER, a positive side load produces a negative yawing velocity.

A solution of the equilibrium equations of motion reveals that the steady state yawing velocity response to a force applied along the positive y axis is positive when the static margin is positive. There is no yawing velocity response when the static margin is zero. The yawing velocity response is negative when the static margin is negative. Using the above definitions of "under" and "oversteer" we see that an understeer vehicle is one which possesses a positive static margin or positive directional stability; an oversteer vehicle possesses a negative static margin or negative directional stability.

So, it appears the automobile's yawing velocity response to steering inputs—that is angular displacement of the front wheels—is basically equivalent to the forward velocity divided by the wheelbase, as modified by the total directional stability of the vehicle . . . which is expressed numerically by its static margin.

Fig. 3 shows how the yawing response to front wheel angle varies with velocity for a vehicle with positive, zero, and negative static margins.

Using terms of curvature response, rather than yawing velocity, transforms Fig. 3 to Fig. 4 . . . and Fig. 4 shows:

- A "neutral steer" vehicle is one which has a constant curvature response with increasing forward velocity;
- An "understeer" vehicle has a decreasing curvature response with increasing forward velocity;
- An "oversteer" vehicle has an increasing curvature response with increasing forward velocity.

Together, Figs. 3 and 4 show that the static mar-

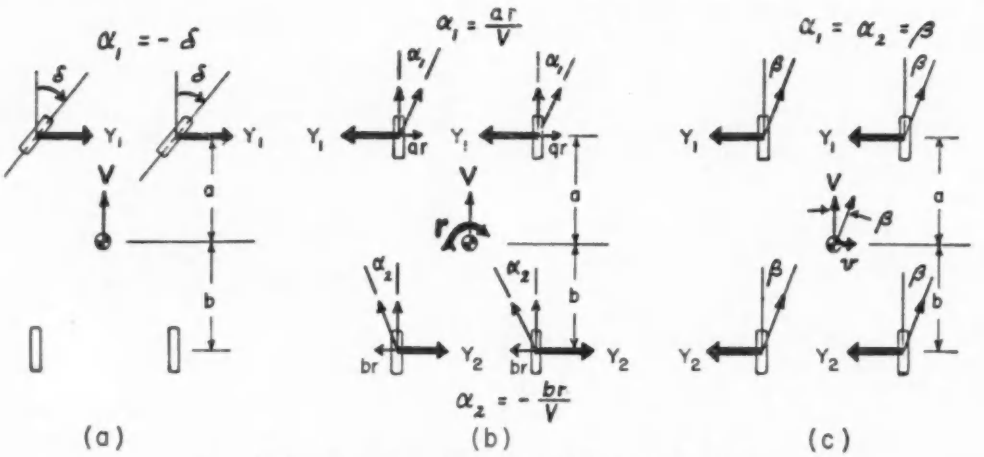


Fig. 1—Forces and moments acting on a car during a steady turn.

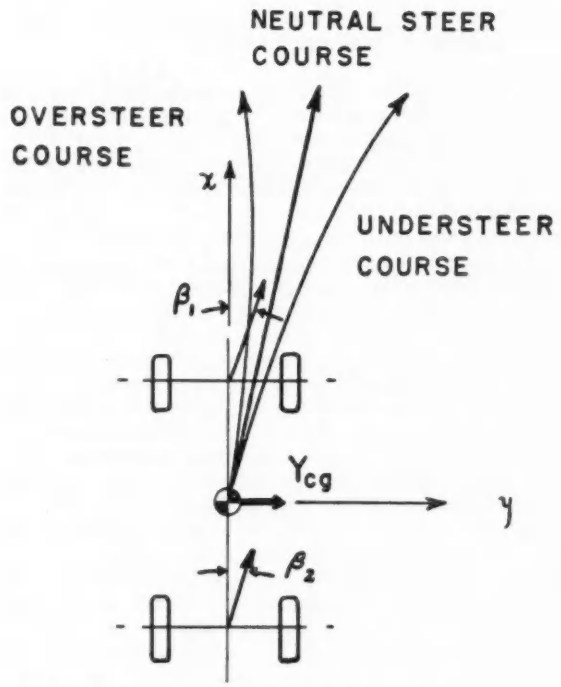


Fig. 2—Understeer representation of vehicle stability.

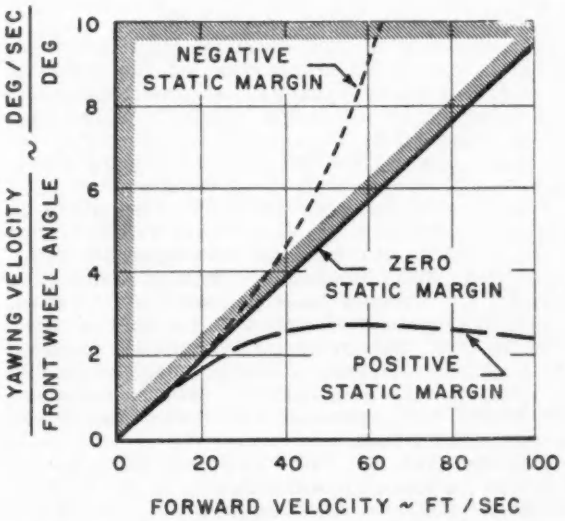


Fig. 3—Influence of static margin on the steady state yawing response.

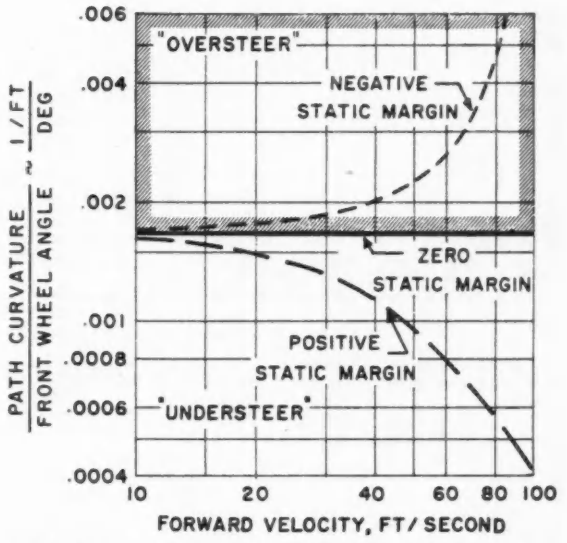


Fig. 4—Influence of static margin on the steady state curvature response.

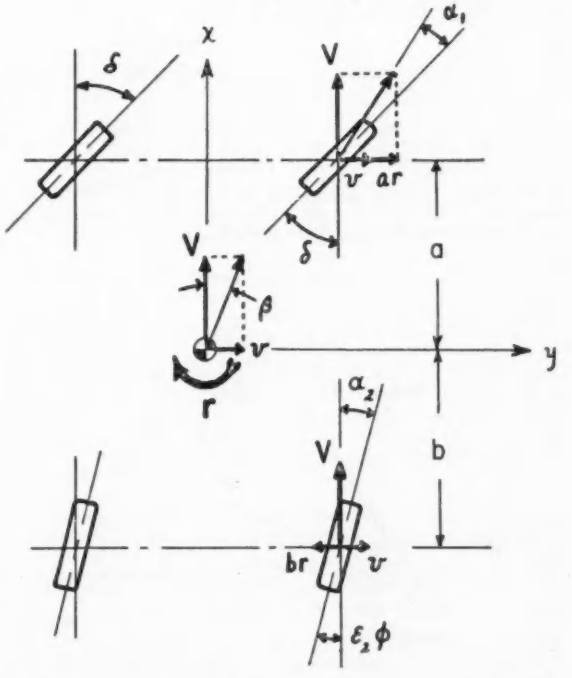


Fig. 5—Slip angles induced by yawing velocity vary inversely with forward velocity.

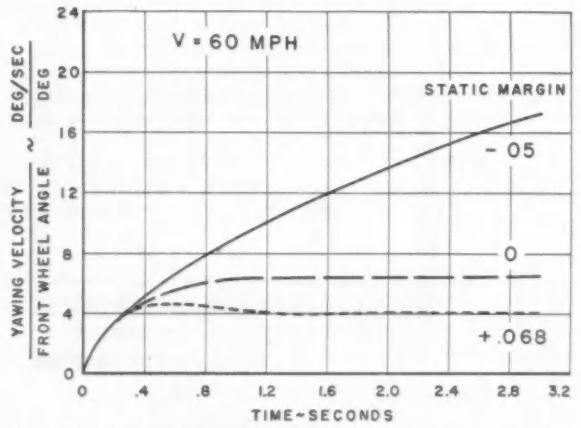


Fig. 6—Yawing velocity response of a '53 Buick to a steering control which is a step input of the front wheel angle—a NEUTRAL STEER vehicle.

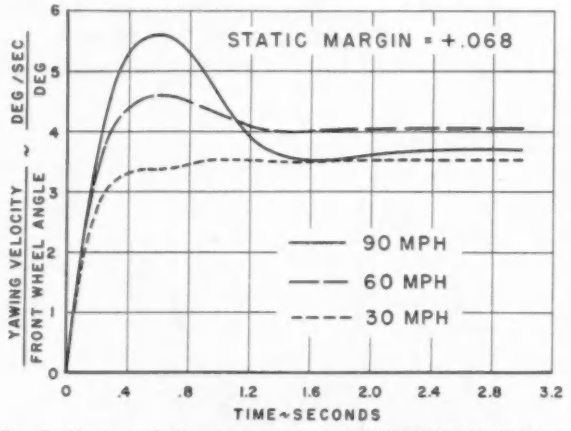


Fig. 7—Yawing velocity response of an UNDERSTEER '53 Buick at speeds of 30, 60, and 90 mph. (The overshoot characteristic will be still larger at speeds higher than those shown.)

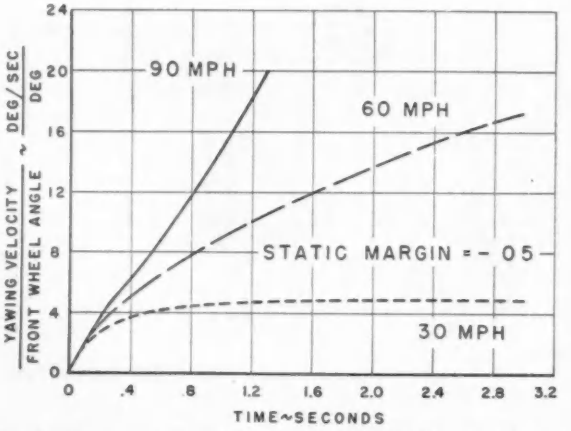


Fig. 8—Yawing velocity responses of an OVERSTEER '53 Buick at speeds of 30, 60, and 90 mph.

gin affects the steady state response, or what is often called the control sensitivity.

The static margin also has a profound influence on the transient response. A negative static margin can produce dynamic instability above a certain critical speed.

Fig. 5 shows that the slip angles induced by yawing velocity vary inversely with forward velocity. Thus the "damping in yaw" decreases in direct ratio to increases in forward speed. If the vehicle is directionally unstable, there will be a certain speed at which the yawing moment due to sideslip and roll angle will just wash out the "damping in yaw" and a given positive control input will produce an infinite response. Mathematically speaking, dynamic instability occurs at this same combination of speed and negative static margin. At this point, a convergent mode represented by a real negative root of the characteristic equation becomes zero and then becomes positive as velocity is increased.

The static margin and the "damping in yaw" are, therefore, the two most important properties governing the control sensitivity and transient response characteristics of an automotive vehicle. Fig. 6 shows the yawing velocity response of the '53 Buick to a steering control which is a step input of front wheel angle. (While step changes in steering can not be achieved in practice, there are significant advantages in studying the response to a mathematical step function.) The step response of the Buick is shown for an "under," "neutral," and "oversteer" configuration at 60 mph. Note that at this speed the oversteer vehicle is just on the verge of becoming unstable. We see that the directional stability as indicated numerically by the static margin, has a significant effect on the transient behavior. Contrary to popular belief, the understeer vehicle is found to be the faster responding vehicle, if speed of response is taken as the time required to reach steady state.

Fig. 7 presents the response of an understeer Buick at speeds of 30, 60, and 90 mph.

The decrease in yaw damping with increasing speed is completely responsible for the indicated change in transient behavior. This overshoot characteristic will be still larger at speeds higher than those shown. This explains, to a large extent, the increased driver attention required to achieve precise control of very high speed vehicles.

Fig. 8 presents the yawing velocity response of an oversteer Buick for the same three values of forward velocity. No overshoot characteristic is encountered with increasing speed in this case. Rather, the response becomes slower as the static sensitivity increases sharply with increase in speed.

At 90 mph, this vehicle is dynamically unstable. It is conceivable that a human may be able to stabilize such a vehicle by means of corrective steering action, but experience has shown that this is a very difficult task.

Together, Figs. 6, 7, and 8 show how static margin (over or understeer) and forward speed affect the transient response of an automobile to steering control. Only by assuming linearity is it possible to obtain a basic understanding of the resultant motion behavior by means of the directional stability and damping in yaw concepts.

At 1956 SAE National Diesel Engine Meeting . . . . Diesels Join High-Output Parade

DIESEL-engine manufacturers—like other engine makers—are being confronted with insistent demands for multiple increases in power. And discussion at the SAE National Diesel-Engine Meeting, held in Chicago on November 1 and 2 showed that they are making every effort to meet these demands by investigating:

- Ways of increasing engine output.
- Problems already arising as outputs go up.

Valuable help on increasing output was presented by Professor Hans List, a prominent European engineer, who pioneered the loop-scavenged engine. He reported that his company had developed it to the point where one model has the phenomenally low weight/power ratio of 5.73 lb per hp (unsupercharged).

He also analyzed supercharging of diesel engines, especially by means of turboblowers. He pointed out that the loop-scavenged engine is particularly amenable to supercharging. He predicted that in the near future supercharging will allow 50–100% increases in output.

Another speaker at the meeting reexamined the long controversial subject of stroke/bore ratio. For the particular type of engine he investigated, he found that, as far as performance is concerned, the long stroke seems to give better performance than when smaller.

Other speakers discussed methods of test to solve problems that, if not new, are becoming more serious as output increases:

- Durability testing to overcome failure of engine component parts.
- Measurement of exhaust gas odor.

Loop-Scavenged Engine

Some engineers apparently feel that this country may have missed a good bet by pretty much neglecting the loop-scavenged 2-stroke diesel. Its low weight/power ratio potentialities and its basic simplicity, thanks to port scavenging, would seem to warrant greater attention by American manufacturers.

Its design does not, however, seem to have been easy, despite the apparent simplicity of its layout.

Some of the problems that had to be solved were, according to Professor List:

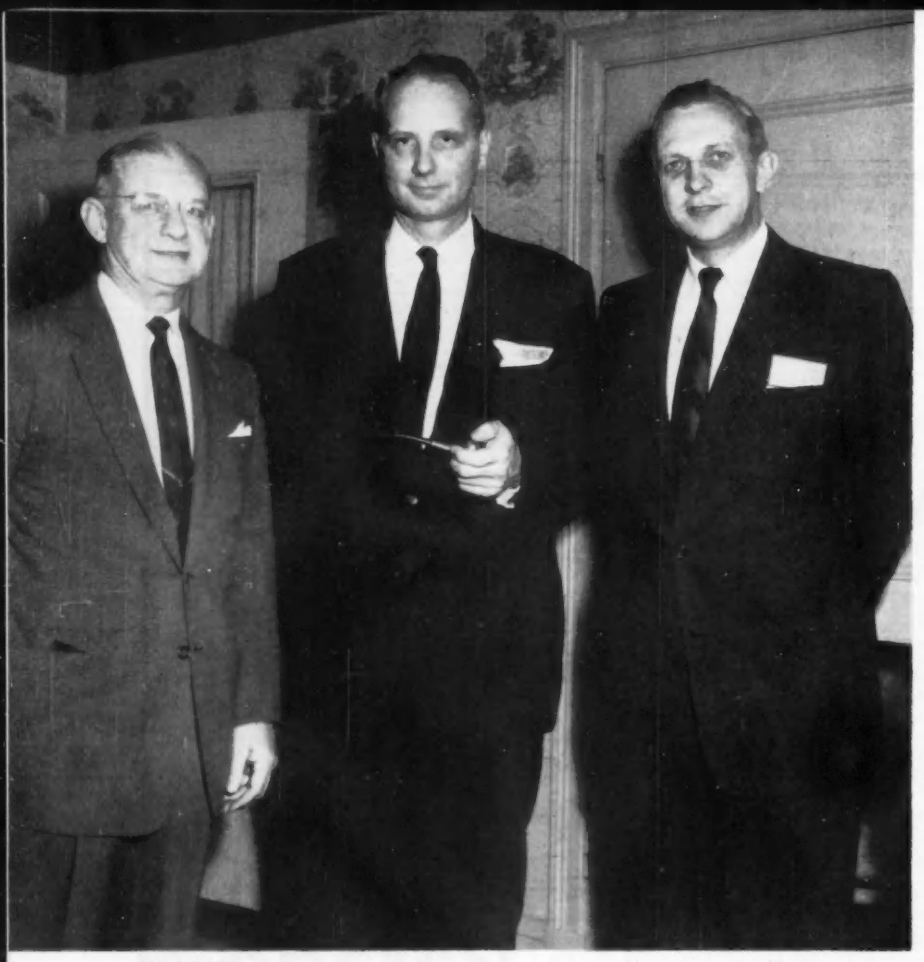
1. To provide a highly efficient charging process.

2. To obtain sufficient but not excessive oil supply to cylinder walls and to obtain reasonable lubricating oil consumption, together with the smallest possible wear.

3. To design the outside shape of the piston so that the side pressure to which the piston is subjected is distributed as evenly as possible over the sliding surface.

To keep development costs down, calculation where possible was employed to investigate the charging process.

To keep oil distribution within limits, the sealing areas at the bottom of the piston must be very



SUCCESS of the meeting was due, in part, to the earnest efforts of these three hard-working gentlemen (left to right): **T. M. Robie,** vice-president of the SAE Diesel Engine Activity, **M. R. Bennett,** meetings vice-chairman of the Activity, and **W. R. Dalenberg,** chairman of SAE Chicago Section.

carefully designed and produced. The problem was licked by paying particular attention to finish of the piston surface, clearances of the piston skirt, finish of the oil scraper rings, and finish of the liners.

Supercharging

Professor List expressed the opinion that the supercharged 2-stroke engine can well compete with the highly supercharged 4-stroke engine. He predicted that it will very likely be superior in cases where simple design and low weight per rated output are important.

Degree of supercharging may be limited, he said due to thermal loading of the piston unless piston cooling is used. This can be accomplished quite simply, he added, by arranging to have the underside of the piston crown sprayed through little holes in the small end of the connecting rod or by separate nozzles. High supercharge at high speeds, he continued, would require pistons with ducts for forced oil circulation.

Another limitation, pointed out by a discusser, was that as supercharging goes up, the maximum cylinder pressure increases at a rate five to eight times as fast as the bmep does. Thus, high cylinder pressure would seem to put a very definite limit on the amount

Continued on page 76

Papers presented at the Diesel Engine Meeting in Chicago, Ill., Nov. 1-2, 1956

Hans List
Anstalt fur Verbrennungsmotoren, Graz-Austria
"High-Speed, High-Output, Loop-Scavenged Two-Cycle Diesel Engines"

K. J. Fleck
Caterpillar Tractor Co.
"Some Effects of Stroke and Bore on Diesel Engine Performance"

F. G. Rounds and H. W. Pearsall
General Motors Research Staff
"Diesel Exhaust Odor—Its Evaluation and Relation to Exhaust Gas Composition"

Symposium—Laboratory Techniques Utilized to Simulate End Product Service Conditions with Regard to Durability

A. H. Fox
Standard Oil Co. (Indiana)
R. A. Pejeau
Cleveland Diesel Engine Division, GMC
Leonard Raymond
Socony Mobil Oil Co.
L. G. Schneider
U.S. Naval Engineering Experiment Station
"Submarines, Snorkel and Sulfur. (Progress Report of the CFR-DFD Group on Deposit Forming Characteristics of Diesel Fuels and Engines of the Coordinating Research Council, Inc.)

W. C. Arnold
Fairbanks, Morse and Co.
"Dynamic Strain Gage Testing of Critical Engine Parts"

S. L. Earle
U.S. Naval Engineering Experiment Station
"Naval Laboratory Tests of Diesel Engines Simulating Fleet Operating Conditions"

M. C. Gillispie and L. A. Grotto
International Harvester Co.
"Determination of the Unknowns in Correlation of Laboratory and Customer Test Results"

Roger Wellington
Detroit Diesel Engine Division, GMC
"Cyclic Testing to Simulate Diesel Engine Service Conditions"

R. C. Schmidt
Cummins Engine Co.
"Choosing the Right Test"

Diesel Engine Meeting Dinner Speakers

DINNER SPEAKERS photographed at a social gathering before the dinner took place: L. F. SHOEMAKER (second from right), general chairman of the meeting, who in his words of welcome called SAE "The greatest factory of ideas in our industry"; A. T. COLWELL (left), who acted as toastmaster; and SAE President G. A. DELANEY (right), who spoke briefly on the work of SAE's Planning for Progress Committee. Delaney also presented a plaque to Shoemaker in recognition of the fine job he did of making local arrangements for the meeting.

Rear Admiral A. B. MUMMA, USN, chief, Bureau of Ships, Department of the Navy (second from left), was principal speaker at the dinner. He discussed the effect of nuclear power on the diesel engine. He said that weight and space requirements for shielding and other major elements of the reactor of a nuclear powerplant will prevent its early adoption in the lighter weight and mobile powerplants in the automotive and transportation industries. It has, however, successfully overtaken the diesel in the submarine chiefly because it confers on the submarine that one vital ingredient—*stealth*. It frees the submarine for the period of patrol from the necessity of surfacing and, for the first time, makes possible the true submarine.

Mumma also said that: The many transformations of energy in the diesel-powered submarine requires a good deal of weight and space. Hence, the extra weight and space of a nuclear powerplant is reasonably competitive. In the surface ship there are fewer transformations of energy, so that nuclear power is going to have greater difficulty invading the surface applications of the Navy because of its excessive weight

However, the almost unlimited endurance of its powerplant gives the nuclear-powered ship a military advantage that makes it imperative that we develop such power for the major surface Navy as soon as possible.

A nuclear-powered guided missile cruiser is in this year's Navy shipbuilding program and the nuclear-powered carrier is included in next year's program, to be presented to the next Congress.

Nuclear power in its present state of development fulfills added needs not yet fully exploited by our current military or civilian economy. It permits things to be done that have never been done before. Hence except in the submarine it is not actually a direct competitor with most currently developed applications of diesel-engine power in the size ranges now contemplated for both types of power.

of supercharging possible, although at this time it appears we can't say what that limit might be.

Stroke/Bore Ratio

Long a long-stroke engine, in recent years the diesel has started to succumb to the modern trend of internal-combustion-engine design to smaller stroke/bore ratios. Actual tests of diesel engines made by one manufacturer show that, at least for the type of engine under test, more power at a lower fuel consumption rate could be obtained with the longer stroke engines.

It was clear, however, that the last word has not been said on this subject. These tests were limited to but one make of diesel, and only performance was considered. In the actual design of an engine, the author pointed out, "The driven equipment requirements of torque and speeds influence and even dictate the design. The engine must be considered as a part of an entire package, with consideration given to the machine we are driving, the types of transmissions and gear reductions involved, and then it must be tailored to meet these requirements."

Durability Testing

Failure of engine component parts is not a new problem to the diesel engine industry. Various methods have been employed in overcoming these problems, which have been encountered as engine ratings and horsepower per pound have increased.

The biggest problem in durability testing appears to be, how to reduce the time of testing. One important technique that gives rapid results, is the relatively new radioactive tracer technique, which, it was emphasized, also has the advantage that it is applicable to conditions as they actually occur in the field.

Another philosophy of testing, reported to have been used by Stan Sparrow, and still to be producing good results consists in aggravating each suspended trouble area drastically, so that failures will come fast. For example, if it is suspected that the bearing surface is insufficient, run the test with half the bearing area. If there is no failure under this condition, then try another possibility. Thus, if hardness is another suspect, reduce it drastically, and run the test again. In this way, Sparrow said, one has a chance of living long enough to find out what was causing the difficulty.

Exhaust Odor

Extensive tests were reported to have indicated no panacea for diesel engine halitosis. The best suggestions stressed the importance of paying close attention to such factors as improved engine and injector design, proper fuel and oil, good maintenance, and avoidance of overloading. For the future, the investigators said, catalytic mufflers (which contain a catalyst to oxidize the hydrocarbons and other materials that ordinarily escape from the combustion chamber unburned) and masking agents (which cover up the unpleasant odor with a more pleasant one) may offer some promise.

Around the Meeting

All agreed that a large share of the success of the technical sessions must be credited to the "participants' breakfasts," held each morning at 8 o'clock. Participants for the day's sessions met for breakfast and an opportunity to get acquainted and plan a smooth-running schedule of the day's technical sessions.

Registration for the meeting was 610, highest ever for an SAE National Diesel Engine Meeting, not held in conjunction with other meetings.

Admiral Mumma gladdened the hearts of his listeners when he said that, although nuclear power is going to take over in the submarine field, it is not going to displace the many diesel engines used in most other applications for many years to come.

At its meeting, the Diesel Engine Activity made final plans for the whole day of sessions devoted to economy fuels for railroad diesels, to be held at the SAE Annual Meeting in January, 1957. The morning session will start off with an introduction by C. G. A. Rosen, who was instrumental in getting the sessions set up.

John A. Newton, Chicago Section membership vice-chairman for their diesel engine activity distributed the membership pamphlet "SAE Is a Sound Investment." It points out the advantages of SAE membership, including: continuing the engineer's education by attending meetings and receiving Society publications, and the benefits from the engineering and business contacts the membership affords.

The Diesel Engine Activity decided to hold its 1958 National Diesel Engine Meeting in Baltimore in October at the same time when the National Transportation Meeting is being held there.

Bouquets to:

The conscientious chairmen who ran the technical sessions, introduced the speakers, and led the discussion: H. L. Wittek, Buda Co., Division of Allis-Chalmers Mfg. Co.; R. E. Kennemer, Caterpillar Tractor Co.; C. F. Taylor, M.I.T.; and M. A. Pinney, Pennsylvania Railroad Co.

The secretaries who recorded the copious discussion at each session: Gregory Flynn, GMC; W. J. Lux, Caterpillar Tractor Co.; E. H. Middendorf, International Harvester Co.; and R. W. Seniff, Baltimore & Ohio Railroad Co.

Farm Tractor Fuels . . .

. . . competing hotly. Regular grade gasoline will continue lead; diesel fuel and LP-gas use will rise, with latter stepping out in some areas.

Based on paper by **H. D. Young**, Sinclair Research Laboratories

REGULAR grade gasoline will continue its nationwide dominance as a farm fuel in the foreseeable future. Factors favoring it are: (a) the high percentage yield from a barrel of crude, (b) the existing distribution system, (c) improvements in tractor engine design to permit gaining performance inherent in high octane number fuel and, (d) changes in tax laws decreasing farmers' price differential between gasoline and other fuels.

The higher price of gasoline is still a disadvantage but it may be decreased by using higher compression engines to gain greater thermal efficiencies, and by improvement in other components. The advantages of using premium grade fuel in high compression engines are looming on the horizon. Refineries will strive to improve the octane number and seek reduction of preignition, elimination of spark plug fouling, and lowering of engine octane demand.

Diesel fuel use will rise because of the favorable price differential in certain localities, its high heat content per gallon, and its operating economy when used in diesel engines.

There are several factors which will have a definite effect on diesel fuel consumption in farm tractors. These are: (a) reduction in price differential betweeen diesel and other farm tractor fuels, (b) increasing thermal efficiencies of other types of farm tractors, (c) higher initial cost of diesel tractors.

LP-gas has outstripped diesel fuel in some sections of the country where the price is favorable. There are several factors favoring greater use: (a) ample supply, (b) low price at point of production; price is tied closely to that of natural gas, (c) high octane number, (d) cleaner burning, (e) increasing availability and, (f) better engine design to capitalize on inherent characteristics.

Major deterrents to LP-gas use are: (a) lower heat value, hence higher consumption when engine has not been designed to offset it, (b) expensive installation cost and, (c) higher distribution costs in certain areas. (Paper "Future Fuel Trends in the Farm Tractor Field" was presented at SAE National Tractor Meeting, September 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

New Tool . . .

. . . to lick problem of noise in aircraft equipment is a portable anechoic chamber made of wood. It provides free-field rather than "dead quiet" conditions.

Based on paper by **B. A. Rose**, Lockheed Aircraft Corp.

LOCKHEED has built an anechoic chamber of unique construction as part of a program to conduct a basic study of aircraft noise. Wood was selected instead of double concrete wall construction so the structure can later be moved.

The walls of the chamber are constructed of 1 in. plywood reinforced with 2×4's in each direction. The chamber assembly consists of an outer inverted box 18 ft high, 20 ft wide, and 24 ft long, resting on a concrete floor and completley surrounding an inner room. The walls of the inner room are of similar plywood construction, suitably reinforced. It is completely isolated from the outer chamber and floats on 63 heavy duty automobile inner tubes. The walls of this inner room are lined with fiberglas wedges approximately 4½ ft long which provide a design cutoff frequency of 50 cps (Fig. 1).

The working space is 7 ft high, 9 ft wide, and 13 ft long. A steel framework supports a piano wire mesh floor approximately 6 in. above the floor wedges. Power, light and instrumentation facilities were designed especially to provide maximum isolation between the inner and outer chambers. Entrance to the working space is given by a removable fiberglas wedge plug, while a tight fitting door with multiple seals closes the outer chamber opening.

The design concept of the chamber involved a compromise in favor of the main proposal which was to provide free-field conditions and not necessarily a "dead quiet" condition. The sound attenuation through the walls of the chamber ranges from about 20 db at 50 cps to better than 70 db above 4000 cps. The inner tube mounting system has a natural frequency of approximately 3 cps which provides good vibration isolation characteristics. The performance of the chamber is considered adequate for the purposes intended. (Paper "New Tools to Lick Aircraft Equipment Noise Problems" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 1956. It is available in full, in multilith form, from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

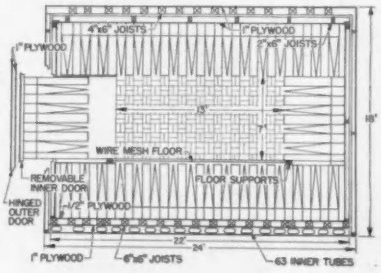


Fig. 1—This anechoic chamber floats on 63 automobile inner tubes. The fiberglas wedges which line the chamber for acoustical absorption, and the piano wire mesh floor are plainly visible.

Engineers Discuss

Truck and Bus Design

Heavy-duty electrical systems and design for ease of maintenance hot topics at SAE National Transportation Meeting.

THE cry for greater electrical capacity and better maintenance design for trucks and buses echoed in the meeting rooms of the SAE National Transportation Meeting held Oct. 10–12 at the Hotel New Yorker in New York. The meeting revealed, however, that present trends point toward meeting these demands.

M. C. Horine, general chairman of the meeting, opened the sessions by welcoming the group that had assembled from all over the country. Three days of technical sessions followed, all well-attended despite competition offered by the World Series.

In addition to the technical talks, the meeting offered a visit to the General Motors Training Center at Union, N. J.; a luncheon where Amos E. Neyhart, Administrative Head, Institute of Public Safety, Pennsylvania State University, spoke on "Mechanic Education and Training"; and, a social hour sponsored by the SAE Metropolitan Section.

The meeting showed that there is good cause for greater electrical capacity in trucks and buses. Starting and ignition systems are demanding higher sparking voltages and increased cranking torques.

Lighting loads are continually on the increase. If we take a tractor, semi-trailer, and full trailer combination and meet all current regulations we find that we may have two headlamps, two parking lamps, six tail lamps, six stop lamps, four turn signal lamps, six identification lamps, eighteen instruments, indicator, and accessory lamps, and eighteen clearance and side marker lamps for a total of sixty-two lamps. This results in a steady night-time lamp load of about 45 amp at 6 v. The stop lamps, turn signals, and other occasional loads add up to another 31 amp. If we add fog and spot lamps, trailer flood, and others, our battery and generator are hard-pressed to meet the demands.

To make matters worse, the trend toward accessories such as the two-way radio and air conditioning add to the load.

The nickel cadmium battery may partially solve the problem. It has a high discharge to unit volume ratio and where performance only is needed, the overall size and weight can be reduced. It seems to require less maintenance and has an excellent life. The high cost of the battery is its main disadvantage, however, and this will have to be overcome if it is to gain acceptance.

Present trends indicate that the

SAE Vice-President for Truck and Bus Activity, F. R. Nail (right) and R. R. Burkhalter, T & B vice-chairman for Meetings (left) discuss order of business for Committee meeting.

Trends

M. C. Horine (left), general chairman of the Meeting, discusses meeting program with General Committee members, Leslie Peat (center) and A. R. Barr (right).

very heavy electrical load of these vehicles may be supplied by an engine driven alternator which will be able to carry the major part of the load at idle. This machine will require something other than conventional cooling and will be enclosed to protect it from foreign substances. It will be designed and built to run between engine overhauls without attention or lubrication. It will be controlled by a static voltage regulator which will give very close control and which will go for very long periods of time, perhaps even for the life of the vehicle, without attention.

About the only way to initiate a program of design for ease of maintenance is to let the designer know exactly what areas of the vehicle present continual maintenance problems. This is exactly what fleet operators at the meeting did. They criticized the present design of some commercial vehicles stating that streamlining is often developed at the sacrifice of utility. The operators recommended practical design to accommodate adjustments, repairs, and replacements, explaining that maintenance costs soar when it is necessary to remove the dashboard to service the windshield wiper motor or to take out the floorboards to reach the spark plugs.

They wanted to know why the manufacturers don't make a sealed brake assembly, stating that the most important single unit on the vehicle is left open to the weather, condensation from exhaust fumes, and all types of matter swirling up from the roadbed.

Why, they asked, does the electrical system, which represents approximately 6% of the total vehicle cost, account for 16% of the maintenance costs.

Can the designer answer these questions? We don't know, but we do know that he now knows the problems, and that's half the battle in designing for ease of maintenance.

Session chairmen were: C. C. Saal, U. S. Bureau of Public Roads; W. K. Creson, Ross Gear and Tool Co., Inc.; E. N. Hatch, Nassau County Franchises; W. M. Kissam, Tidewater Oil Co.; Robert Gardner, Regular Common Carrier Conference of American Trucking Associations, Inc.; and L. E. Moody, Esso Research & Engineering Co.

Session secretaries were: C. P. Hoffman, Jr., American Trucking Associations, Inc.; Henry Jennings, Fleet Owner; M. K. Simkins, Chilton Co.; and G. S. Tobias, Esso Research & Engineering Co.

Papers presented at the SAE National Transportation Meeting

E. B. Ogden, vice-chairman for meetings of the Transportation and Maintenance Activity Committee presided at a Committee luncheon session.

Left to right are: C. E. Chambliss, Jr., SAE Metropolitan Section chairman; T. L. Preble; A. E. Neyhart, and SAE President G. A. Delaney. Neyhart, guest speaker at the Transportation Meeting luncheon, spoke on "Mechanic Education and Training." Preble was toastmaster at the luncheon.

were: "A Resumé of Bus Suspensions" by A. B. Hirtreiter, The Goodyear Tire and Rubber Co.; "The Engineer in Fleet Maintenance" by Theodore McGill, Director of Safety, Department of Sanitation, City of New York; "Stopping Ability of Motor Vehicles Selected from the General Traffic" by F. W. Petring, U. S. Bureau of Public Roads.

Symposium—Design for Maintenance: "Design and Its Effect on the Maintenance of Trucks and Tractors" by A. W. Neumann, The Willett Co.; "Design for Maintenance" by G. E. Heiber, Boston, Worcester, and New York Street Railway Co.; "The Future of Trailer Maintenance" by Andrew Ambli, Briggs Transportation Co.

Symposium—Trends in Heavy Duty Electrical Systems: "Trends in Motor Coach Electrical Systems" by R. H. Bertsche, GMC Truck and Coach Division; "Electrical Trends in Motor Trucks" by G. W. Hostetler, International Harvester Co.; "New Look in Series Parallel Systems" by J. V. Poticny, The Leece-Neville Co.; "Electrical Equipment-Heavy Duty Progress" by H. L. Hartzell, Delco-Remy Division, General Motors Corp.

Symposium—Unusual Vehicles: "Trucking Problems in Alaska" by R. C. Norrie and R. H. Kasper, Kenworth Motor Truck Co.; "Hauling Huge Loads—1000 Arctic Miles" by L. E. Burgess, Mack Trucks, Inc.; "Surface Transportability and Its Influence on Design of Military Vehicles" by Sumner Meiselman, U. S. Army Transportation Corps.

Members and guests board bus for visit to the General Motors Training Center at Union, N. J. The group witnessed GM's Mechanics Training Program in action.

T & B Plans Improved Technical Services for 1957

S. J. Tompkins,
1957 SAE Vice-President for Truck & Bus Activity

Tompkins is chief engineer, Truck Operations, Dodge Division, Chrysler Corp.

THE Truck & Bus Activity next year plans to dig deeper than ever before into available technical resources for engineering ideas and information. Its aim: better service to SAE members. Specific steps toward that end are being planned—much along lines first taken by the Production Activity three years ago.

To start, the T & B Activity Committee meetings will become chiefly round-table discussions. In face-to-face discussion we will try to identify in specific terms the most acute problems and the most interesting developments facing truck and bus engineers in 1957. Composed of working leaders in truck and bus engineering the Committee is well adapted to getting into the open practical questions which are crying for answers.

It will probably supplement these face-to-face discussions with written study reports. These will come from individual committeemen (or small groups) who have agreed to explore for the Committee problems of some area which, the Committee suspects, may need extensive development.

Both the Committee discussions and the special explorations, of course, will be kept to practical focus through written summaries . . . and these will be important helps to the three subcommittees which we plan to set in motion. These working groups will bring to specific fruition the Committee's work of setting up and presenting the best possible papers for SAE meetings.

TO DECIDE ON AND PROCURE PAPERS for specific meetings we will select from the Activity's membership a *Meetings Steering Committee.*

> Before each Activity Committee meeting, this group will gather to complete tentative technical programs for T & B sessions for future meetings as required. . . . It will have for guidance the results of the full Activity Committee's *last* round-table discussions.
>
> This MSC may also list technical areas of interest as potential agenda for the full Committee's *next* round-table discussion.

TO READ PAPERS OFFERED FOR PRESENTATION—and to recommend their disposition to the Activity Committee, a *Paper Review Committee will be established.*

> The PRC will recommend that the submitted paper be accepted or rejected. . . . (If accepted—whether it might best be scheduled for full presentation at a meeting; presented by title at a meeting; or suggested to some SAE Section.)

TO REVIEW PROSPECTIVE NATIONAL MEETING LOCATIONS and recommend sites for future meetings, a Committee on National Meeting Locations and Section Relationships will be continued.

Each Activity Committee round-table will usually be preceded by reports from each of these three subcommittees.

Swapping Ideas via Round-Tables

The round-table itself is likely to start from the tentative list of areas of technical interest brought together by the Meetings Steering Committee. This list will be designed as a round-table discussion pump-primer. Additional and related subjects will flow spontaneously from the group as discussion goes forward. Exchangers will reveal the most acute problems facing the assembled engineers and their associates back home . . . and some notions about who may have a few of the answers.

To keep the discussions in practical focus, the chairman will aim to get Committee determinations on each of the topics that get serious attention. That focus may well be in something like the following terms:

1. "Hot"
   In which case, the Meetings Steering Committee might be "instructed" to schedule a paper at an early session.

2. "Probably hot"—little information readily available, but more may be dug up
   In which case, an individual or special small group may be asked to explore further and report back to the next Activity Committee Meeting . . . defining the problem, and including data on what's being done here and there to solve it in part or as a whole.

3. "More suitable for some other group"
   In which case, some other Activity or group would be notified.

4. "Of little interest"
   In which case, the problem will simply be dropped.

Through this intensified attack and the changed methods, our hope is to bring to SAE members served by the Truck & Bus Activity a series of benefits already realized by those whom the Production Activity serves. These benefits would seem to include:

1. Papers whose technical ideas and aims have come from a crucible of face-to-face discussion among leading truck and bus engineers (the Activity Committee round-table) *before* being shaped into specific papers for actual presentation;

2. Development of a reservoir of material through which specific meetings programs can combine advance planning with timeliness at the date of presentation to a greater extent than ever before;

3. Published summaries of the Committee round-tables will make available much interesting technical information to all of SAE's 22,000 members much earlier than ever before;

4. The Activity Committee meetings—by stimulating greater exchange of technical ideas among the Committee members themselves—will make those meetings of greater direct technical value to those who attend.

O. E. Hunt . . .

. . . received 1956 SAE Beecroft Award on October 22 at National Safety Congress in Chicago.

O. E. HUNT, director of General Motors Corp., formerly GM executive vice-president and chairman of the Automobile Manufacturers Association's Engineering Liaison Committee, received the SAE Beecroft Memorial Award and presented the 1956 Beecroft Lecture on October 22 during the National Safety Congress in Chicago.

Pyke Johnson, former president, Automotive Safety Foundation, and 1946–1949 chairman, Beecroft Traffic Safety Engineering Award Committee, presented the award.

Lecture Published

This last of a series of 10 Beecroft Lectures, was published in full in the November *SAE Journal*, pages 64–67. It has also been published as a monograph and made available for widespread distribution, as were the preceding lectures. The Award has been made annually for 10 years for "substantial contributions to the safety of traffic involving motor vehicles." It originated in the terms of a $2500 bequest by the late David Beecroft, president of SAE in 1921.

Hunt was selected to receive the award because of his leadership in designing and building safety into automotive vehicles. He was the driving force in the cooperative engineering work that resulted in the sealed-beam lighting system—an outstanding contribution to highway safety.

Hunt was elected vice-president of General Motors Corp. and became responsible for the coordination of the company's technical activities in 1929. He was named to the Board of Directors in 1934. On Nov. 2, 1942, he became executive vice-president of General Motors. He retired on Sept. 30, 1949, but remains a director.

Following his graduation from the University of Michigan in 1907, he entered immediately into the engineering and construction business. From 1907 to 1909 he was superintendent of construction for John Russell Pope, architect, in New York City, and the George A. Fuller Co. in Washington, D. C. In 1909 he joined the Packard Motor Car Co. in Detroit. After serving as draftsman, chief draftsman of the truck division, body engineer, assistant to the vice-president, and assistant chief engineer, he became chief engineer of the car division. He held this position in 1918 when he resigned to become associate district manager at Detroit and chief engineer in charge of Liberty aircraft-engine design and production for the U. S. Government.

Following World War I, Hunt rejoined Packard as chief engineer of the car division. From 1920 to 1921 he was vice-president in charge of operations for Hare's Motor in New York, and in 1921 became chief engineer for the Chevrolet Motor Co. in Detroit.

Moral Responsibilities Needed

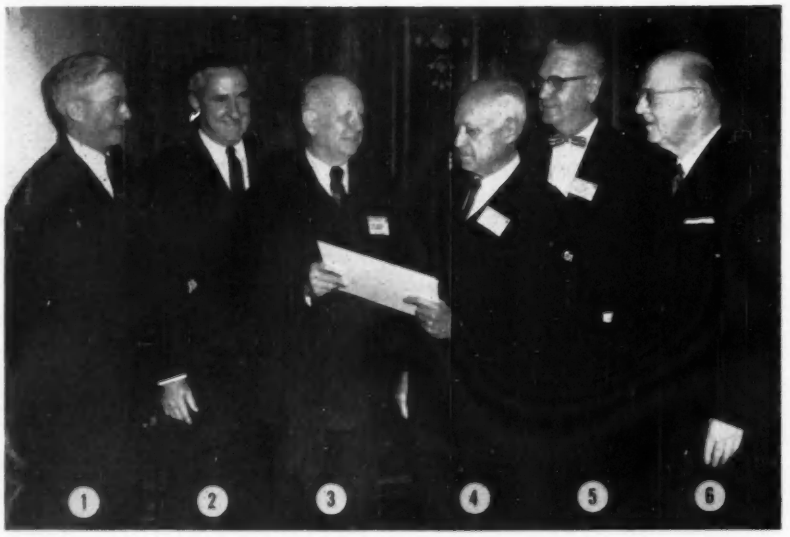
In his lecture, which covers the entire field of automotive traffic safety, Hunt sums up his feeling by forewarning that accidents will occur despite our best efforts at engineering, enforcement, and education—although at perhaps reduced rates—"until the man behind the wheel grows in understanding of his own moral responsibilities . . . until he feels driving to be a privilege of modern life . . . and life to be an opportunity to do for others what he wishes them to do for him."

"Such understanding," he says, "cannot be enforced or engineered. But educational emphasis and re-emphasis on the moral responsibility of the individual for his own acts can be expected to make continued progress.

"Fear of punishment or pain is not enough to ensure safe use of the highways. We must look for new educational techniques, for new ways to stir the will to the right action—just because it is right. The moral responsibility which stimulates the dedicated men who devote their lives to the furthering of the three E's must be increasingly injected into the highway user.

"Finally, may I say that if we are to get this job done, all of us must support the constructive efforts of our legislative bodies and our administrative agencies to cope with this major problem of our time. Let's keep in mind that the common good may call for some of us to make sacrifices, and that now and then our own toes may be stepped on. And let us recognize from the outset that getting this job done will cost money—large sums of money. If we get the result we all hope for, it will be well worth the price."

Beecroft Award Participants



O. E. Hunt (4),1956 Beecroft Memorial Award recipient and lecturer, displays the certificate he received to the other participants in the Beecroft Lecture program.

(1) **SAE President George Delaney,** who, after the lecture, made a short speech of appreciation to all who had participated in the Beecroft Lecture Series.

(2) **J. N. Bauman,** president, White Motor Co., and chairman, Beecroft Memorial Award Lecture Committee, who introduced Pyke Johnson.

(3) **Pyke Johnson,** former president, Automotive Safety Foundation, and 1946-1949 chairman, Beecroft Traffic Safety Engineering Award Committee, who presented the Award to Hunt.

(5) **Robert E. Raleigh,** Citizens Traffic Safety Board of Metropolitan Chicago, and general chairman, Traffic Section National Safety Council, who presided at the session.

(6) **Ned H. Dearborn,** president, National Safety Council. The NSC has been host for the past several lectures.

Junior grade members . . .

. . . called into military service, may subscribe to SAE Journal for $3 per year.

TO encourage junior grade members to continue their affiliation with SAE after they have been called into military service, they may now subscribe to the SAE Journal for $3 per year.

Previously they were placed on Reserve Member status, which required them to subscribe to SAE Journal at the $10 nonmember rate.

Most of these junior members are formerly enrolled students who, had they not applied for regular membership, could have continued their enrollment while in service or postponed submitting their application until their military commitment was finished.

For further information write to SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

YOU'LL . . .

. . . be interested to know that . . .

The SAE was a cosponsor of the ASME Annual Meeting on Air Cargo, on November 26–28 in New York City, held as part of the 1956 ASME Annual Meeting. Papers at the meeting covered: airfreight sales development, air cargo terminal design, cargo loading and unloading, all-cargo aircraft requirements, airport planning, and the helicopter as flying crane. Highlight of the meeting was a tour of the air cargo handling facility at the New York International Airport. This facility is reported to be the largest and most modern in the world. It can handle 20 aircraft and 100 trucks simultaneously.

Robert F. Lybeck represented President Delaney and the Society at the Northeastern University Dedication Exercises for the Classroom Laboratory Building and Twenty Years of Progress, in Boston, on October 24.

T&FM . . .

. . . Activity Committee decides Milwaukee is best place for National Tractor Meetings.

AT a recent meeting, the Tractor and Farm Machinery Activity Committee voted to continue holding the National Tractor Meeting in Milwaukee, at least in the immediate future. This decision was made on the recommendation of the subcommittee on National Meeting Locations and Section Relationships which studied the advisability of changing the meeting site.

Consensus was that good meetings could be held in other midwest centers of the tractor industry, such as Chicago, Minneapolis, Peoria, Detroit, or Cleveland, but none offered all the advantages of Milwaukee. It was pointed out that because the meeting has been held in the same city for many years and has been solidly supported by the SAE Milwaukee Section, it has grown steadily in popularity. The 1956 meeting established a new attendance record with over 1600 registrations.

RIBLET . . .

. . . to give 1957 Buckendale Lecture.

ROBERT M. Riblet, chief engineer, Automotive Division, Timken Roller Bearing Co., has been selected to give the 1957 L. Ray Buckendale Lecture, Ernest P. Lamb, chairman of the Buckendale Lecture Committee, announced recently.

The committee has asked Riblet to discuss bearing applications for heavy-duty axles, gathering data from other manufacturers where necessary. In accordance with the general objectives of the Buckendale Lecture series, it is to provide practical procedures and data useful in the solution of problems of design, and it is to be directed to the needs of young engineers and students.

The lecture will be given at a special student and junior member meeting sponsored by the SAE Cleveland Section during the week of Nov. 3, 1957. Three national meetings, the SAE National Transportation, Diesel-Engine, and Fuels & Lubricants Meetings will also be held in Cleveland during this period.

Other members of the committee that served with Chairman Lamb in selecting the lecturer are: R. R. Burkhalter, E. F. Petsch, M. A. Thorne, and C. A. Lindblom.

SAE National Meetings

1957

January 14-18
Annual Meeting and Engineering Display
The Sheraton-Cadillac and Statler Hotels
Detroit, Mich.

March 5-7
Passenger Car, Body, and Materials Meeting
The Sheraton-Cadillac
Detroit, Mich.

March 20-22
Production Meeting and Forum
Hotel Statler, Buffalo, N. Y.

April 2-5
Aeronautic Meeting,
Aeronautic Production Forum
and Aircraft Engineering Display
Hotel Commodore, New York, N. Y.

June 2-7
Summer Meeting
Chalfonte-Haddon Hall
Atlantic City, N. J.

August 12-15
West Coast Meeting
Olympic Hotel, Seattle, Wash.

September 9-12
Tractor Meeting and Production Forum
Hotel Schroeder, Milwaukee, Wis.

October 1-5
Aeronautic Meeting,
Aircraft Production Forum,
and Aircraft Engineering Display
Ambassador, Los Angeles, Calif.

November 4-6
Transportation Meeting
Hotel Statler, Cleveland, Ohio

November 5-6
Diesel Engine Meeting
Hotel Statler, Cleveland, Ohio

November 6-8
Fuels and Lubricants Meeting
Hotel Statler, Cleveland, Ohio

Former Chairman of Committee E-25 Receives Plaque

ROBERT C. RETHMEL (left) recently received a plaque from the hands of Brig.-Gen. L. I. Davis, Commander of Holloman Air Development Center, New Mexico. The plaque was prepared by Committee E-25, Engine and Propeller Standard Utility Parts in appreciation for Rethmel's leadership as chairman of E-25 from May 1952 to January 1956.

Jet Reversers May Double As In-Flight Air Brakes

Based on paper by

J. H. POVOLNY
and
J. G. McARDLE
NACA Lewis Flight Propulsion Laboratory

THRUST reversers for aircraft jet engines appear useful as in-flight brakes as well as for reducing ground roll after touch-down.

The effectiveness of the thrust reverser as an in-flight brake is illustrated in Fig. 1, which shows a comparison of the time required for decelerating a 20,000-lb airplane at an altitude of 25,000 ft when it is equipped with a conventional aerodynamic dive brake with that required when the same airplane is equipped with a thrust reverser providing 50% reverse thrust.

For a reduction in flight Mach number from 0.9 to 0.7 the time required for the dive brake was 26 sec. (That required for the thrust reverser was only 15 sec.) Thus, it appears that the thrust reverser will have some advantages as an in-flight brake.

If the reverser is used to modulate thrust during the landing approach, the airplane will be able to land with a lower thrust, at a lower speed, with a faster thrust recovery time than is presently possible. Also, the time required to produce the full braking force (reverse thrust) is considerably shortened because the engine is maintained at rated conditions and does not have to be accelerated to produce full reverse thrust.

(Paper "NACA Investigation of Thrust Reversal Techniques" was presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, October, 1955. Complete paper contains considerable information on NACA's investigation of both target types and cascade types of thrust reversers.)

Faster Fuel Pump Means Less Vapor Lock

Excerpts from paper by

R. A. RANDALL
Fuels and Lubricants Department, GMC

ONE way to increase the vapor-handling capacity of the diaphragm-type fuel pump is to run it at engine rather than cam speed. In this way the vapor-locking tendency of the fuel system should be lessened.

This is so for the following reason: In order to prevent vapor lock, the weight of fuel equivalent to the full-throttle fuel requirement (ftfr) of the engine must be supplied. It appears that if this weight can be supplied at a larger volume flow, that is, a larger vapor to liquid ratio (**V/L**), the **vapor-handling capacity** of the system can be increased at vapor lock. One way of obtaining a larger volume flow with a given pump is to run it at a higher speed.

For example, with a certain pump, it was found that the ftfr, for a cam speed of 600 rpm, could be pumped at a **V/L** of 64, if the pump was run at engine speed (1200 rpm). In other words, the pump should still prevent vapor lock, even though the **V/L** of 34, which was limiting on the bench test setup at a pump speed of 600 rpm, has been exceeded. Therefore, the **vapor-handling capacity** of the system has been increased by running the pump at engine speed rather than cam speed.

In the vehicle on the chassis dynamometer, it was found that the ftfr at an engine speed of 1200 rpm could be pumped at a **V/L** of 67 if the pump was also operated at 1200 rpm. At a speed of 600 rpm (cam speed), the pump could not supply the ftfr above a **V/L** of 36.

A possible fallacy in this reasoning is that in improving the vapor-handling capacity by going to a higher pump speed, the **vapor-forming tendency** of the system may have been changed. The change has probably been in the direction of increasing the vapor-forming tendency. Thus, at a given ambient condition, with a given fuel, a gain because of an increase in vapor-handling capacity may be partially offset by a loss due to an increase in the vapor-forming tendency. It would be interesting to determine the effect of increasing the pump speed from cam to engine speed on the vapor-locking tendency of a vehicle on the road. The customary acceleration-type vapor-lock tests on the road add the complicating effects of transients and float bowl capacity, which are absent from steady-state bench and chassis tests.

One other item that must certainly be considered in the practical sense is that the carburetor may not be able to handle a **V/L** of, for example, 64 even though the weight flow should be sufficient to supply the engine demand. In fact, this discussion raises the question of whether or not the attack on the vapor-lock problem should be directed toward reducing the **vapor-forming tendency** of the fuel or fuel system rather than increasing the vapor-handling capacity of the fuel system. It is encouraging that

Continued on page 101

SECTIONS

DECEMBER 1956

Student Paper Competition Round-Up

1. What makes a prize-winning student paper?

2. Should a student paper be judged in the same manner that one experienced engineer would judge the remarks of another equally experienced engineer?

3. Must the judges look for some new and revolutionary theory before a student paper will prove worthy of engineering consideration?

A report from Sections which have instituted student technical papers contests indicate a staunch "no" to questions two and three. The answer to the first question, "What makes a prize-winning student paper?", is embodied in a combination of two principles—technical correctness and effective delivery.

While the first point of this criterion, technical correctness, does suggest independence, originality, knowledge of subject, research, and logical development of theme, it in no way demands that the student provide the basis for an ingenious project, a novel experiment, or a new theory.

The second part of the criterion, effective delivery, requires only that the speaker be clear and concise, have a natural, interesting, and direct manner, and use correct English.

The Sections which sponsor technical paper competition and answered the poll were:

Central Illinois,
Cincinnati,
Pittsburgh,
St. Louis,
Southern California,
Spokane-Intermountain,
Western Michigan.

Competition Procedure

The contest procedure in all the Sections except Western Michigan stated that those participating must be enrolled SAE Student Branch members. The number of participants vary in each Section, depending on the number of schools involved and the size of the Section.

Western Michigan Section conducts a special type of contest among pre-engineering students at Muskegon Community College and Grand Rapids Junior College, since there are no regular Student Branches within the Section.

It should also be noted here that the Southern California Section competition is not solely a technical paper contest. Better known as the **Mac Short Award** contest, this competition is held not only to pick a prize-winning paper but to select that particular student who represents completely the best overall engineering student in the competition.

With only one exception the Sections' contests rules state that the subject to be discussed by the speaker is to pertain to the automotive field. Southern California is the exception, stating: "We did not in any way specify the subject matter for the individual students. We felt that it would take a certain amount of judgment on their part to pick a subject on which they could write a good paper and which would be of interest to the governing board."

The Cincinnati Section in its contest rules broke down the automotive theme into more particular subjects, such as, SAE activities in aeronautics, passenger cars and other component parts, fuels and lubricants, and construction and industrial equipment.

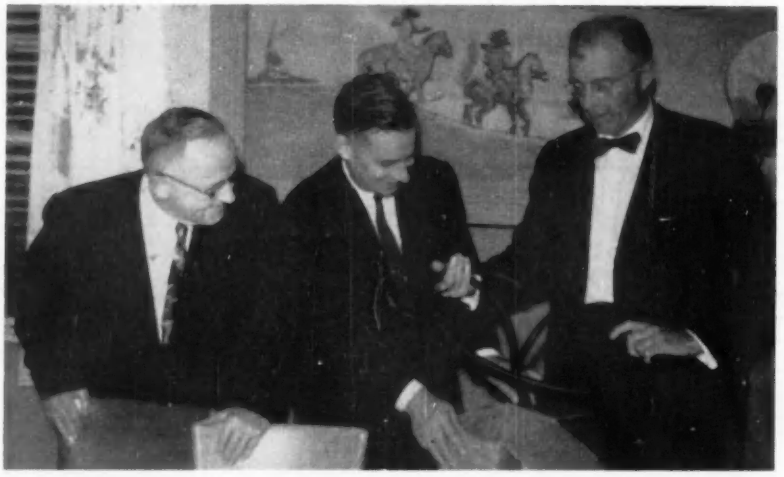
The time element varied very little in all the contests rules. In some instances, the procedure states a length limit rather than time limit for the talks, such as 2,000 words. However, the average limit for each talk is 15 minutes.

The Judges

The panel of judges vary in each section with an SAE three-member panel predominating. Cincinnati Section provides that the faculty advisor, the Student Activity vice-chairman, and one member of SAE from the Cincinnati Section act as judges.

Prizes include certificates and plaques and cash awards. Southern California has the unique idea of offering a perpetual trophy. Each year the winner's name is inscribed on the trophy and the school of the award winner is given custody of the trophy during the annual award period.

New England Section Fetes President-Elect Eddy



Two scenes at left show both the formal and informal moments of the dinner given in honor of SAE President-Elect W. Paul Eddy by the Governing Board and past-chairmen of the Southern New England Section on Oct. 22.

In the upper photo Section Past-chairman **Edward S. Marks** (left), and 1956–1957 Section Chairman **Spencer W. Deming** (center) enjoy **SAE President-Elect Eddy's** bewilderment as he opens a box at the dinner given in his honor.

In the lower photo Section past-chairmen and members of the Governing Board pose with SAE President-Elect Eddy. Standing from left to right are Past-chairmen **Hans Hogeman, Edward S. Marks, Robert E. Johansson, L. Morgan Porter, Claude O. Broders,** and **Richard C. Molloy.** Seated left to right are **Section Chairman Deming, SAE President-Elect Eddy,** and Section Past-chairmen **Frank P. Gilligan** and **Charles W. Phelps.**

DETROIT

G. J. Gaudaen, Field Editor

Automation was the theme of the paper presented by **Val W. Baran,** Industrial engineer of the Cross Co. of Detroit, at the Section's Oct. 2 meeting. Baran brought out the fact that automation will be felt not only in industry but in the homes as well.

Over 1,000 members and guests at the Detroit Section's Oct. 8 meeting heard the fine points of powerplants discussed by three of the nation's leading engineers.

Darl F. Caris, head of the automotive engines research department at General Motors Corp. brought out the remarkable refinements of the piston engine of today. **George J. Huebner, Jr.,** executive research engineer for Chrysler Corp., maintained that the gas turbine holds the greatest promise. **Dr. Donald N. Frey,** associate director of Ford Motor Co.'s scientific laboratory, indicated the future may be with the free piston-turbine.

Philadelphia

E. V. Henc, Field Editor

Philadelphia Section members were treated to a demonstration on computation by the Burroughs Corp. in the company's downtown office at the Oct. 10 meeting of the Section. Following the tour, **Dr. Herman Epstein** of Burroughs Corp. discussed both the method of programming and basic design principles of computers in the automotive, aviation, and petroleum industries.

SYRACUSE

D. J. Ritchie, Field Editor

Fifteen students and three faculty members from Syracuse University were part of the 115 persons attending the "kick-off" meeting on Oct. 9 which featured Gregory Flynn, Jr., assistant head, mechanical development department, Research Laboratories Division, General Motors Corp., as guest speaker. The attendance of the student group and faculty members was part of a move to establish a Student Branch at Syracuse University.

Mohawk-Hudson

C. F. Hastie, Field Editor

Highlight of the Section's Oct. 9 program was a talk on project "Orion" by **Ralph Hooker** of the General Engineering Laboratory, General Electric Co.

Special guest at the meeting was **Henry Fischbeck,** who was presented a plaque honoring his 35 years of membership in SAE by Section Chairman **L. F. Smith.**

From Section Cameras

1 **Rear Admiral James S. Russell** of the Navy Bureau of Aeronautics was guest speaker at the Washington Section Oct. 16 meeting. Preceding the meeting, some 120 members and guests toured the Naval Air Test Center at Patuxent River.

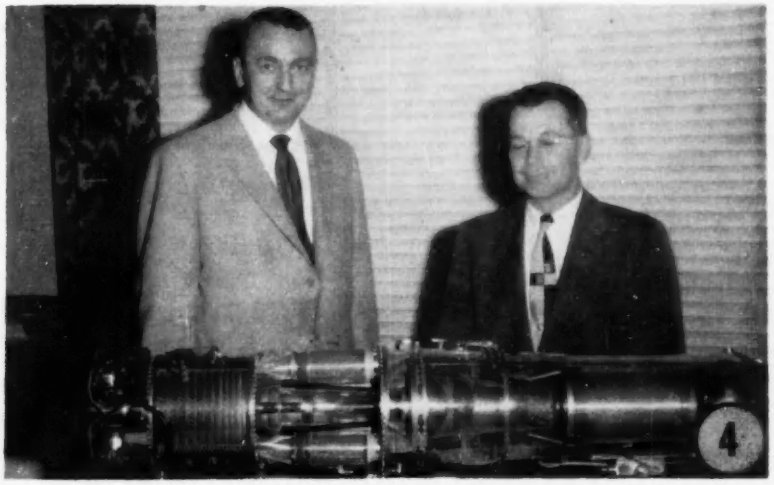
2 **Rear Admiral Clifford H. Duerfeld,** commanding officer, Naval Air Test Center, addresses the group at a dinner held at the Cedar Point Officer's Club following the tour.

3 **W. W. Cornman** (right), **Central Illinois Section** technical chairman for the Oct. 22 meeting, discusses points of the paper, "The Highway Story," presented by **Theodore Morf** (seated) of the Illinois highway department. Joining in the discussion are **G. P. Koch** (left), Section vice-chairman for Springfield, and Section Chairman **R. H. Henderson** (center).

4 **R. L. McBrien,** technical chairman for the Oct. 24 meeting of the **Northern California Section,** introduces guest speaker **J. D. Wethe,** manager, marketing, Aircraft Gas Turbine Division, General Electric Co. Wethe used a model of J-47 axial flow engine used in the F-86 shown here to demonstrate his remarks on commercial jet engines.

Preceding the talk, the Section Past-chairman "Jewel Award" was made to **Trescott S. White** of Enterprise Diesel in recognition of his service during 1945–1946.

A. T. Colwell of Thompson Products discussed "New Developments by Thompson in Fields Outside of the Automotive" during the coffee hour.



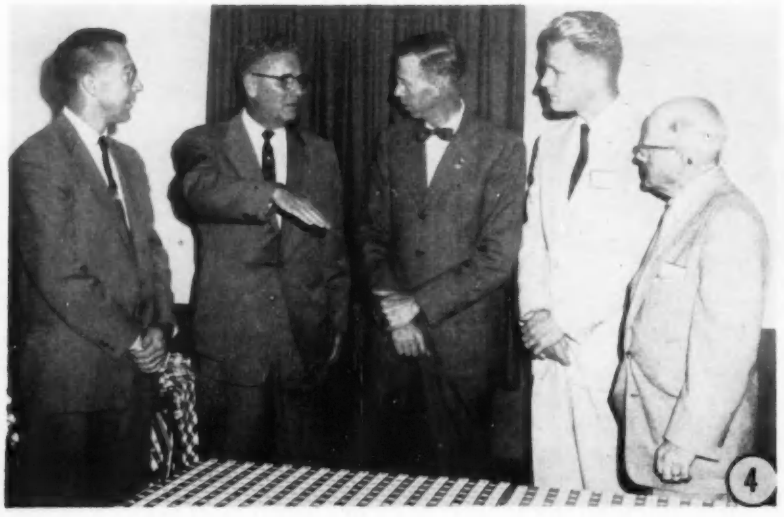
From Section Cameras

1 Members of the **Twin City Section** relax at the Southview Country Club dinner after a tour of the Great Northern Oil Co. Refinery on Oct. 10.

2 **Twin City Section Chairman S. H. Knight** (right) thanks **W. J. Carthaus** (left), president, Great Northern Oil Co., leader of the panel discussion which followed the plant tour.

3 **W. W. Squier,** vice-president of Sun Electric Corp., answers "the whys" on maintenance problems during the question and answer period at the **Atlanta Section's** Nov. 5 meeting. Following his talk, "Clinical Inspection a Boon to Maintenance," there was a film shown on "The Importance of Engine Tune-up Diagnosis."

4 "Gliders" is the topic under discussion by this SAE group at the Nov. 6 meeting of the **South Bay Division** of the **Northern California Section** following a talk given by **Ted Nelson** (center) of the Nelson Specialty Corp. on "Gliding with the Auxiliary Powered Hummingbird." **E. W. Rentz, Jr.** (second from left), manager SAE Western Branch Office, illustrates a point as So. Bay Division Chairman **Frank Jarrett** (left), Technical Chairman **Claude Hess** (second from right) and Northern California Section Chairman **Elvin Lien** (right) listen in.



CINCINNATI

A. R. Ehrnschwender, Field Editor

A. B. Clark, manager, sales, Technical Division of the Standard Oil Co. of Ohio, told the Cincinnati Section about "The Trouble With Gasoline" at the Oct. 20 meeting. The speech stimulated a blend of serious and humorous discussion which further enlightened the guests on the chemistry of gasoline.

New England

George T. Brown, Field Editor

One hundred and forty-five SAE members and friends were on hand for the opening meeting of the New England Section, which was conducted by Bus and Truck Activity Chairman **O. E. Johnson.**

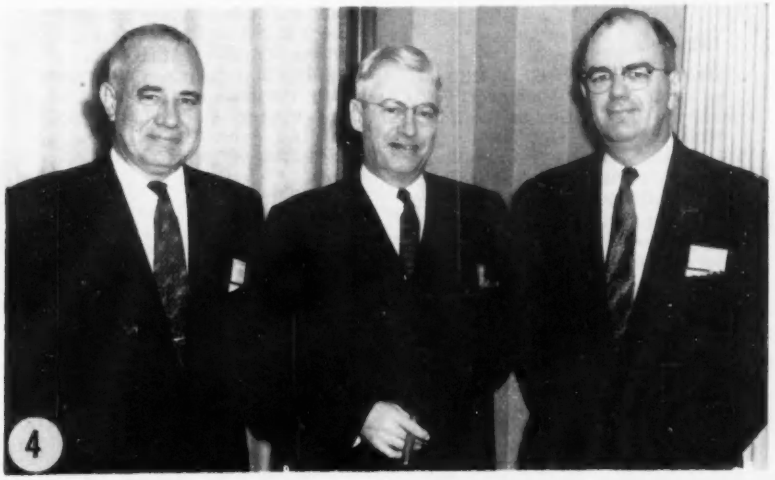
Nelson R. Brownyer, vice-president of Timken-Detroit Division, Rockwell Spring and Axle Co., Detroit, made forecasts on truck transmission improvements at the meeting.

1 **Dr. C. G. A. Rosen,** SAE past-president and consulting engineer for Caterpillar Tractor Co., is welcomed by **Kansas City Section Chairman Charles A. Slater, Jr.** at the Oct. 25 meeting. In his speech, "Thumbing Through an Engineer's Notebook," Rosen went behind the scenes to point out highlights of engineering thinking which have brought the diesel to its present preeminent position.

2 Featured speaker at the Nov. 26 meeting of the Cincinnati Section was **K. L. Campbell,** manager of truck tire engineering, Firestone Tire & Rubber Co., who spoke on "Trends in Tire Design."

3 Texas A & M Student Branch members were special guests at the Oct. 12 meeting of **Texas Gulf Coast Section.** Members heard **M. W. Corzilius,** research engineer, E. I. du Pont de Nemours & Co., Inc., pose the question "What Next—Fuel Injection, Free Piston or Gas Turbine?"

4 **SAE President George A. Delaney** (center) gathers with **Dayton Section Chairman Mearick Funkhouser** (left) and Section Meetings Chairman **E. S. Moyer** (right) for a Journal photograph at the Section's Oct. 23 meeting.



5 Later, members heard **President Delaney** tell about "Designing an Automobile." Seated at the speakers' table are (left to right) **C. L. Richter,** Arrangements chairman; **C. P. Kelley,** secretary; **Tom Lord,** treasurer; and **E. S. Moyer,** Meetings Chairman.

Salt Lake City

J. C. Bates, Field Editor

Max J. Tauschek, chief engineer, Valve Division, Thompson Products, Inc., emphasized important features of his talk, "Basic Factors Affecting Engine Valves," with slides and curves at the Section's Oct. 9 meeting.

ST. LOUIS

F. H. Myers, Jr., Field Editor

SAE Student Branch at the Missouri School of Mines and Metallurgy got together with the school's ASME Student Branch on Oct. 17 to hear **R. W. Kiecker** of Allis-Chalmers Mfg. Co., talk on "Nuclear Power."

Section Meetings

BALTIMORE

December 13 . . . K. A. Browne, director of research, Chesapeake & Ohio Railway, Cleveland.—"Highway Trucks by Rail." Engineers Club. Dinner 7:00 p.m. Meeting 8:00 p.m.
January 10 . . . Fuels & Lubricants Meeting.

BUFFALO

January 8 . . . Plant Tour. Dunlop Tire & Rubber Corp., Sheridan Dr. & River Rd. Dinner 6:45 p.m. Meeting 7:45 p.m.

CENTRAL ILLINOIS

December 17 . . . Member Meeting. **Walter J. McCulla,** general supervisor, Caterpillar Tractor Co., Peoria.—"Rating of Diesel Engines." **Edgar Cheaney,** designer, Allis-Chalmers Mfg. Co., Springfield.—"Final Drive Design." **E. W. Spannhake,** director, engineering & research, LeTourneau-Westinghouse Co., Peoria. — "Electrical Controls." Pere Marquette Hotel. Dinner 6:30 p.m. Meeting 7:45 p.m.

INDIANA

December 13 . . . O. D. Dilliman, assistant chief engineer, Advanced Chassis Design, Engineering Division, Chrysler Corp., Highland Park.—"Power Steering." Indianapolis Naval Armory Mess. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Features: Film on Suspension System of Chrysler Automobiles.

NEW ENGLAND

January 8 . . . Lewis C. Kibbee, chief, Automotive Engineering Section, American Trucking Associations, Inc., Washington, D.C. —"Maintaining the Maintenance Manager." M.I.T. Faculty Club, Cambridge. Dinner 6:45 p.m. Meeting 8:00 p.m. Special Features: Social Hour 6:00 p.m.

PHILADELPHIA

December 12 . . . Harry A. Toulmin, Jr., research engineer, Ethyl Corporation, Ferndale, Mich.—"Effect of Fuel Volatility on Starting and Warm-up of New Automobiles." The Engineers' Club. Dinner 6:30 p.m. Meeting 7:45 p.m. Special Features: Technical Chairman, **F. C. Burk,** assistant director, Application Research Division, Atlantic Refining Co.,

ST. LOUIS

January 8 . . . Ladies Night.

SAN DIEGO

December 13 . . . Dinner at Luback's. Meeting Solar's Auditorium.
January 10 . . . Dinner at Luback's. Meeting Solar's Auditorium.

SYRACUSE

January 8 . . . T. A. Bissell, SAE manager, Meetings Division.—"Technical Highlights of the 1957 Cars." King George Motel. Dinner 6:30 p.m. Meeting 8:00 p.m.

TEXAS

December 14 . . . Automobile Meeting.
January 11 . . . Joint SAE and IAS Meeting.

TWIN CITY

January 9 . . . S. M. Weckstein, chief engineer, Industrial Division, Timken Roller Bearing Co., Canton, Ohio.—"Lubrication of Anti-Friction Bearings." Hasty Tasty Restaurant. Dinner 6:45 p.m. Meeting 8:00 p.m. Special Features: Joint Meeting American Society of Lubrication Engineers.

WASHINGTON

December 18 . . . George A. Delaney, 1956 SAE President.—"Designing An Automobile." International Room, Occidental Restaurant. Social Hour 6:15 p.m. Dinner 7:00 p.m. Meeting 8:00 p.m.

The following reported that they have no meetings scheduled between December 12 and January 12:

BRITISH COLUMBIA SECTION

METROPOLITAN SECTION

MID-MICHIGAN SECTION

MILWAUKEE SECTION

PITTSBURGH SECTION

SOUTH TEXAS GROUP

VIRGINIA SECTION

CANADIAN

F. G. King, Field Editor

There was a record attendance at the annual Niagara Peninsula meeting of the Canadian Section held on Oct. 18. **Gregory Flynn, Jr.,** assistant head of General Motors Corp.'s mechanical development department, inspired an active question and answer period following his talk outlining the "Free Piston Engine."

NORTHWEST

B. H. Murray, Field Editor

"How is the temperature in the various portions of the valve determined?" was one of many interesting questions at the Oct. 12 meeting. Queries were prompted by Thompson Products' chief engineer **Max J. Tauschek's** paper "Basic Factors Affecting Engine Valves."

PITTSBURGH

H. J. Grance, Jr., Field Editor

Enthusiastic reception of the speaker's paper at the Oct. 23 meeting was evidenced by the numerous questions during the discussion. Responsible for the lively session was **Carl S. Ryan,** chief automotive technologist, eastern region of E. I. duPont de Nemours & Co., Inc., with his paper, "Automobiles of the Future."

BUFFALO

J. D. Walsh, Field Editor

Colored motion pictures and slides depicting developments and features of free piston engines were shown at the joint session of the Rochetser Division and The Buffalo Section on Oct. 11. Films and slides were part of the talk "The Free Piston Engine" which was presented by **Gregory Flynn, Jr.,** assistant head, mechanical development, Research Laboratory Division, General Motors Corp.

1957 SAE Annual Meeting And Engineering Display

Detroit, Mich.
Jan. 14-18, 1957
The Sheraton-Cadillac Hotel
Hotel Statler

Over **60 technical papers** in 25 sessions
Sessions sponsored by each of the **12 SAE Activities**
1957 Annual Meeting Dinner—Detroit Masonic Temple
Engineering Display—The Sheraton-Cadillac Hotel, Jan. 14-18

SPECIAL EVENTS . . .

Laboratories Tour—Tuesday, Jan. 15
. . . an all-day tour to the Aeronautical Laboratories at the University of Michigan

Presidential Address—Tuesday evening, Jan. 15
Annual business session announcing election of 1957 officers, presentation of life memberships, presentation of Annual Report

LUNCHEONS . . .

Passenger Car Activity—Monday, Jan. 14
"Basic Research and the Automotive Industry"

Production Activity—Wednesday, Jan. 16
"Opportunities Unlimited for Engineers in Manufacturing"

Air Transport Activity—Friday, Jan. 18
"Progress Report on Aviation Facilities Planning"

About SAE

BAMBOO RAM (BOB) TEREE has been appointed chief engineer of Greer Hydraulics, Inc., Jamaica, N. Y. Prior to joining Greer, from 1951 to 1956, Teree was with the Weatherhead Co. of Cleveland as chief engineer of the company's Aircraft and Special Products Divisions.

From 1931 to 1946, Teree was in charge of the hydraulic group with the Curtiss-Wright Corp. In 1946 he joined the Weatherhead Co. where, for three years, he served as project engineer in charge of the development of aircraft equipment and as the director of the company's laboratories.

From 1949 to 1951, he worked as the director of engineering of New York Air Brake Co.'s Hydraulic Division, returning to Weatherhead in 1951.

LEONARD J. HADDEN has been made chief engineer at Stainless Steel Products, Inc., Burbank, Calif. Previously, he had served as chief project engineer for the company.

JULES KENDALL has been made vice-president in charge of research and development of the newly established Research and Development Division of Greer Hydraulics, Inc. Since 1952 he has served as vice-president in charge of sales at Greer.

Kendall has been with the company since 1945.

ROBERT E. DYAS has been appointed manager of contract refrigeration sales for Perfection Industries Division, Hupp Corp. He had been director of technical services for the division.

Dyas joined Hupp in 1948 as service manager of the Refrigeration Products Division.

Teree

Hadden

Kendall

Dyas

Hohmann

Stauffer

Pisasale

Charlebois

CONRAD J. HOHMANN has been appointed assistant chief engineer—special airborne devices for Vickers, Inc. Previously, he was assistant director of research and engineering at Houdaille Industries, Inc., where he had been employed for the past year. For the two years prior to joining Houdaille, Hohmann was assistant chief engineer for Warner Division of Detroit Harvester Co.

GORDON E. STAUFFER has joined Vickers' aviation gas turbine components group as an application engineer. Prior to joining Vickers, Stauffer was sales engineer handling special assignments and military contracts for the Aircraft Division of Holley Carburetor Co.

SALVATORE F. PISASALE has been made mechanical design engineer, Kirk Engineering Co. He is a company representative to Philco Corp. in Philadelphia. Previously, he was senior mechanical designer with Kirk.

ERNEST A. CHARLEBOIS has become an owner-partner in the San Diego Auto Auction and Federal Motor Sales, located respectively at 4744 and 4706 Federal Boulevard, San Diego, Calif. He is also an owner-partner of Miracle Corner at 1040 National Ave., National City, Calif. Previously, Charlebois was a senior design engineer in Convair's air conditioning design section.

THOMAS A. NICHOLSON has been named sales manager of the Piston Ring Division of Thompson Products, Inc. Prior to this appointment, he was Detroit district manager of the division.

GEORGE C. TREVARTHEN succeeds Nicholson as Detroit district manager of the Piston Ring Division. For the past two years he has served as a sales engineer with Thompson Products.

EMERSON W. CONLON has been appointed general manager of the Turbomotor Division, Curtiss-Wright Corp. Prior to this appointment, he was director of engineering, Fairchild Engineering Division, Fairchild Engineering and Airplane Corp.

JOHN F. BURRIDGE, formerly Dayton representative of the United Aircraft Service Corp., has been named an assistant sales manager of Hamilton Standard Division, United Aircraft Corp.

ALFRED B. THACHER succeeds Burridge as Dayton representative of United Aircraft Service Corp. Prior to this appointment, he was chief sales engineer for propellers at Hamilton Standard.

MORGAN JONES has been named chief sales engineer for propellers for the division. Previously, he was a field engineer for the division.

JAMES R. WYNNE has been named chief engineer, proving grounds, Kiekhaefer Corp., Oshkosh, Wis. Previously, he was assistant director of research for Kiekhaefer.

ABRAHAM ZUKERMAN is now an instructor at the University of Southern California. Formerly, he was an instructor at the California Institute of Technology.

Members

Nance

Zechel

Punke

Long

Yokel

Black

Beltz

Macdonald

JAMES J. NANCE has been named vice-president—marketing, Ford Motor Co. Prior to joining Ford, he had been president of Studebaker-Packard Corp.

Nance will be a member of the Ford administration committee and serve as chairman of the company's merchandising committee.

WILLIAM J. ZECHEL, formerly vehicle engineering manager for Studebaker-Packard Corp., has been appointed chief automotive design engineer for American Motors Corp.

A 23-year veteran in automotive engineering, Zechel entered the automobile field in 1933 in body work at Packard Motor Car Co.

In 1942, he was made supervisor of all experimental aircraft engine test equipment. Three years later, he was named automotive designer on major engine and chassis components.

Zechel was appointed assistant chief draftsman for the Engine and Chassis Division in 1951, and was named vehicle engineer in 1955.

J. J. PUNKE has been made executive vice-president of the Precision Castings Division, Harsco Corp. Prior to this new appointment, he had been vice-president, engineering and manufacturing, for Precision Castings.

Punke will be in complete charge of all the operations and affairs of the Precision Castings Co., reporting only to the president and board of directors of Harsco Corp.

RICHARD C. LONG, formerly eastern representative, sales, Warner Electric Brake and Clutch Co., has joined Truck Equipment Co., as a sales representative.

Long's SAE Metropolitan Section activities include chairman in 1948–1949, vice-chairman in 1947–1948, treasurer in 1945–1946–1947, vice-chairman for passenger car in 1944–1945, and Reception Committee vice-chairman in 1943–1944.

EDWARD C. YOKEL, previously assistant chief engineer, General Products Division, Twin Disc Clutch Co., Racine, Wis., has been named chief engineer of the division.

Yokel started at Twin Disc in 1937 in the engineering department. He was transferred to the Hydraulic Division the next year, and in 1945 was made assistant chief engineer of that division. In 1950 he was transferred back to the General Products Division as its assistant chief engineer.

JAMES B. BLACK has been made chief engineer of Twin Disc's Hydraulic Division in Rockford, Ill.

Black joined Twin Disc in 1941 as a design engineer at the Hydraulic Division. In 1950 he was made assistant chief engineer of the division.

GEORGE R. ASCHAUER succeeds Yokel as assistant chief engineer at the General Products Division. Formerly, he was supervisor of mechanical design for the division.

JOHN B. BELTZ, formerly an experimental engineer with the Oldsmobile Division of General Motors Corp., has been appointed assistant chief engineer at Oldsmobile in charge of body and sheet metal design and engineering standards.

In 1947, Beltz joined Oldsmobile as a senior clerk in the dynamometer laboratory. He advanced to engineering test supervisor in 1953 and to experimental engineer in 1954.

LEONARD JAMES MACDONALD, formerly superintendent of Rolling Stock for the Montreal Transportation Commission, has been named general manager for the Ottawa Transportation Commission.

Macdonald first entered the transit field in 1946 when he joined the Montreal Tramways Co. as engineer of equipment.

In 1952, Macdonald was named superintendent of equipment for the company, which had changed its name to Montreal Transportation Commission. In 1956, he was made superintendent of Rolling Stock.

A native of Aberdeen, Scotland, Macdonald served as a Wing-Commander in the R. A. F. during World War II.

WILLIAM C. GOULD, vice-president and general manager of Diesel Engine Corp., College Point, N. Y., has retired. He will reside in Mount Dora, Fla.

EDWARD A. NEU, JR., has been made manager, Advanced Rocket Projects Division, Wright Aeronautical Division, Curtiss-Wright Corp. Prior to this appointment, he was senior engineer, Aerojet-General Corp., Sacramento, Calif.

EDWARD P. SULLIVAN is now a design engineer, component development group, preliminary design department, Transport Division, Boeing Airplane Co. Before joining Boeing, he was a designer in the development department for Republic Aviation Corp.

Lockheed Executive Changes

Gross | Haughton | Hibbard | Johnson | Squier

ROBERT E. GROSS has resigned as president of Lockheed Aircraft Corp. He will continue as chairman and chief executive officer of the company.

Four other SAE members are included in Lockheed changes.

DANIEL J. HAUGHTON has been named executive vice-president. Formerly, he was vice-president and general manager of the Georgia Division.

HALL L. HIBBARD, vice-president of engineering, has been made a senior vice-president of the company.

CLARENCE L. JOHNSON, formerly assistant vice-president of engineering and research, has been made vice-president of engineering and research.

CARL B. SQUIER, who was one of the founders of the company in 1932, will continue as a vice-president and becomes assistant to the chairman.

GEORGE B. WOOD, JR., is now a test conductor with Convair Division, General Dynamics Corp. Previously, he was chief, Development Division, Naval Underwater Ordnance Station, Department of the Navy. Wood resides at 5243 Electric Ave., La Jolla, Calif.

JOHN H. McCOY is now a field engineer with AC Spark Plug Division of General Motors Corp. He was a mechanical engineer at the New York Naval Shipyard in Brooklyn.

CARL H. LINN has resigned as president and general manager of Union Petroleum Co., Council Bluffs, Iowa. He has organized a new firm, Industrial Lubricants, Inc., Omaha, Nebr.

EDGAR H. DIX, JR. has been presented the Albert Sauveur Achievement Award for his outstanding work in aluminum alloys research by the American Society for Metals. Dix is assistant director of research at the Aluminum Co. of America's Aluminum Research Laboratories in Pittsburgh.

GEORGE SPATTA (right), president of Clark Equipment Co., is presented with a citation for his "outstandng achievements" from the Cooper Union for the Advancement of Science and Art by Harrison Tweed (left), trustee of the Cooper Union. The citation read, in part: "You have gained pre-eminence in the manufacturing of road-building and material handling equipment. Your inventive resourcefulness is attested to by 31 patents you hold in the field of mechanical engineering. Through your activities in such bodies as the Engineering Council of the University of Notre Dame and the Society of Automotive Engineers you have gladly shared your wide experience for the benefit of your profession."

CHARLES F. KETTERING, 1918 SAE president and consultant for General Motors Corp., was awarded a scroll in behalf of the American Medical Association on his 80th Birthday.

More than 1000 attended the event honoring Kettering for his contribution to science. The award was presented with these words:

"He is the kind of man who gives himself in helping others get new projects started. He will travel hundreds of miles to aid some man who has an idea."

Another scroll was presented by the National Inventors Council, of which Kettering is a past-chairman.

Kettering also has been selected unanimously as the industrialist of the year by the Society of Industrial Realtors and will receive the Society's 1956 Industrial Award Trophy.

W. LAURANCE SHAFFNER, director of the fleet section of General Motors Corp., has retired. Schaffner had been with General Motors for 33 years, having joined the sales promotion staff of the GMC Truck and Coach Division in 1923. Three years later he transferred to the Pontiac Division of GM as director of the commercial car and fleet department.

In 1930, Schaffner moved to the central office as sales promotion manager. In 1946, he was named head of GM's fleet section activities.

WILTON MARGRAVE, formerly chief engineer for the Cleveland Division of Parker Aircraft Co., Los Angeles, has been transferred to Los Angeles to direct hydraulic engineering activities for Parker Aircraft.

WILLIAM G. WEBSTER will succeed Margrave as chief engineer for the Cleveland Division. He was a project engineer at Parker.

HARRY P. DOBROW is now production engineering design specialist with Lockheed Aircraft Corp. Formerly, he was with Westinghouse Electric Corp.'s Atomic Power Division in an advisory engineering capacity.

Dobrow began in the engineering field in 1937 as a mechanical engineer with York Corp.

From 1940 to 1942 he was a mechanical engineering draftsman and later head instructor in drafting for Pratt & Whitney Aircraft Division, United Aircraft Corp.

During World War II he served as consulting engineer—automotive, and project engineer on a group of engines for Office, Chief of Army Ordnance, SOS Headquarters, first at the Pentagon and later at Guardian Building, Detroit.

From 1945 to 1947 he was head of design calculations department in the Product Engineering Division of Willys-Overland Motors, Inc. In 1947 he was made assistant to chief division engineer, Chassis Engineering, Hudson Motor Car Co.

In 1953, he joined Alloy Engineering and Casting Co. as assistant chief engineer. Later, he was named assistant to the vice-president at Alloy. Two years later he joined Westinghouse.

RICHARD J. SCHAGER, formerly assistant chief engineer, automotive and diesel products, Cleveland Graphite Bronze Co., has been named director of manufacturing engineering for the company.

RICHARD ARNOLD, who was senior product engineer, field engineering at Cleveland Graphite Bronze, has been named manager, testing and evaluation, product engineering staff, for the company.

ROBERT H. JOSEPHSON is now manager, new product development, product engineering staff, Cleveland Graphite Bronze Co. Previously, he was a senior product engineer for the company.

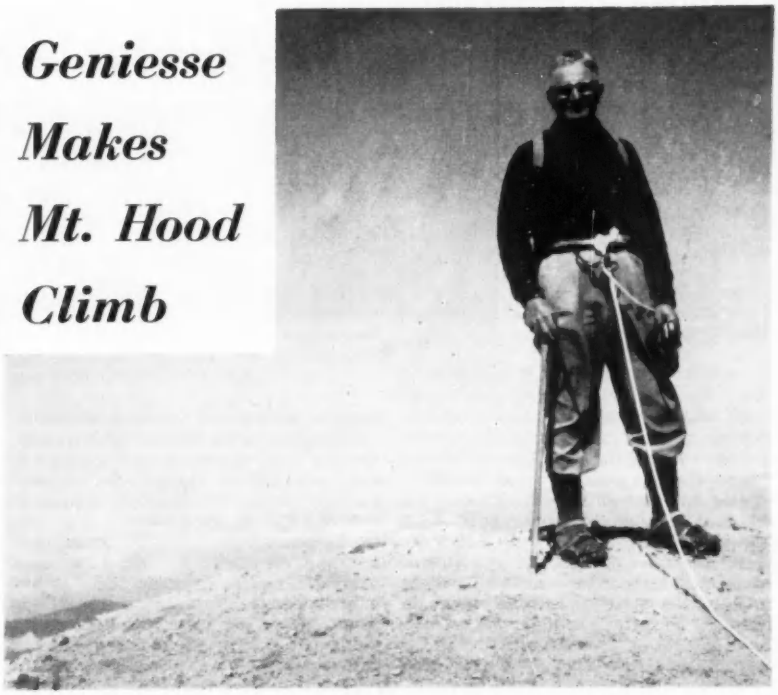
WILLIAM A. WEINKAMER has been made manager, bearing and engineering, product engineering staff for Cleveland Graphite Bronze.

ROBERT W. FLEMING has joined the Bettis Plant, atomic power research laboratory which Westinghouse Electric Corp. operates at Pittsburgh for the Atomic Energy Commission. Prior to this, he was assistant professor of mechanical engineering at the University of Wisconsin.

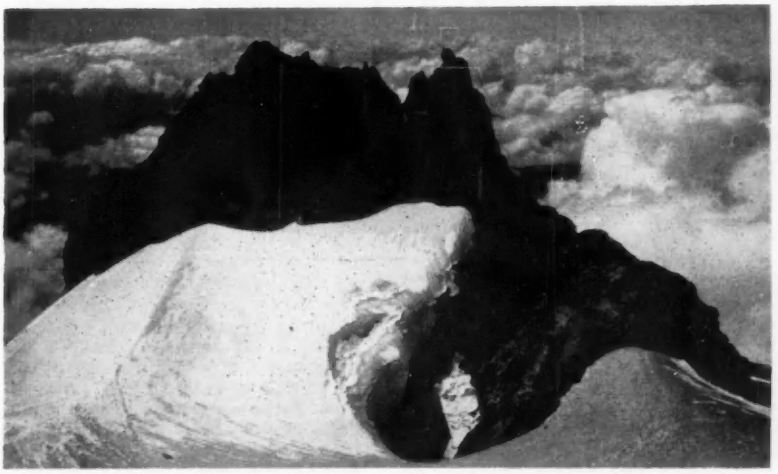
Fleming will perform reactor design work for the scientific development of nuclear propulsion equipment for atomic-powered ships.

EDGAR T. SCHREINER is now manufacturing relations engineer for Sandia Corp., Albuquerque, N. M. Previously, he was production product engineer, engineering staff, Ford Motor Co.

Geniesse Makes Mt. Hood Climb



John C. Geniesse reaches the top of Mt. Hood. The Geniesse father and son team roped up the peak to save each other in case of slip.



Mt. Hood, the highest peak in Oregon, is sighted by the Geniesse expedition.

JOHN C. GENIESSE, director, application research, research and development department, Atlantic Refining Co., answered the call of the wild last August when he and his son James made an expedition to the top of Mt. Hood.

The elder and younger Geniesse found the scaling no easy matter, since all climbing was done on snow or ice from the time they left the lodge until they reached the top.

Geniesse is strictly an apprentice in the mountain climbing field, being a resident of Philadelphia where he served as 1935–1936 SAE Section chairman and is a past vice-president for Fuels and Lubricants Activity.

GM Transmission Division Changes

Habel Doidge Herndon Qualman Dolan

O. WILLIAM HABEL has been appointed general manager of the Detroit Transmission Division, General Motors Corp. He was general works manager of Saginaw Steering Gear Division for General Motors. He had been with GM since 1923.

As a member of SAE, he is co-author of a motion picture concerning time and motion study principles which is recognized as authoritative and which has been reproduced and used for training in approximately 30 universities and 60 industrial organizations.

JACK R. DOIDGE has been made chief engineer of the Detroit Transmission Division. Previously, he was senior project engineer for the Oldsmobile Division of General Motors.

Doidge entered the automobile engineering field in 1940 with the Chrysler Corp. In 1951 he joined the Oldsmobile Division as senior project engineer.

WALTER B. HERNDON, who was works manager, Detroit Transmission Division, has been named director of sales and engineering for the division.

He began his GM career in 1928 in the Cadillac engineering department. He has been closely associated with the Hydra-Matic transmission since the start of its development, joining the division in 1939.

Herndon's SAE activities include several panels and papers concerning automatic transmissions for the Detroit Section.

JACK W. QUALMAN is now assistant chief engineer of Detroit Transmission Division, in charge of future product design and development. Formerly, he was a section engineer, engineering staff, Transmission Division.

Qualman joined the division in 1939 and in 1945 was transferred to GM central office where he worked with the transmission development section.

THOMAS E. DOLAN has been appointed experimental engineer of the Detroit Transmission Division. He joined the division in 1941. Since 1953 he has been staff engineer in charge of truck, bus, and military transmission engineering programs.

CHARLES N. TRIPP is now an engineer, accessories and controls subdivision, Marquardt Aircraft Co., Van Nuys, Calif. Formerly, he was a hydraulic engineer, Detroit Transmission Division, General Motors Corp.

JOHN W. HIGGINS, president and treasurer of Worcester Pressed Steel Co., has been elected chairman of the board of directors for the company.

Higgins is the founder and director of the Museum of the John Woodman Higgins Armory and Plant of the Worcester Pressed Steel Co. The museum, which is an altruistic research laboratory and library of historical information, exhibits, in chronological order, the evolution and products of all times and places—the Stone, Bronze, and Iron Ages, and now the Steel Alloy Atomic Age.

MAURICE B. RICE has been appointed regional service manager, sales, in Boston for the Chrysler Corp. Previously, he was service manager, Eastern Division, sales, for Chrysler.

Rice has been in service activity with Chrysler for 20 years. In his new position, he will supervise activities of field service specialists and technical education for Chrysler dealers in New England area.

ARTHUR J. DAVIDSON, JR. has been named associate director, staff research and development, automotive, for Thompson Products, Inc.

Davidson comes to Thompson from the Budd Co. of Detroit, where he served as assistant administrative engineer in the Wheel Division.

He began in the engineering field in 1943 as a designer for General Motors Corp. Later he became project engineer in the Overseas Division. He was stationed in Melbourne, Australia, from 1946 to 1950.

From 1950 to 1955, Davidson was in charge of the components engineering department in the Ordnance Division of Chrysler Corp.

JAMES E. YINGST has been appointed manager of the staff research and development, automotive, at Thompson.

He joined Thompson as a research engineer in June, 1955. In February he was promoted to assistant manager of the company's staff automotive department.

CHARLES A. CASHION has been named manager, transportation section, traffic and transportation department, Koppers Co., Inc. Formerly, he was assistant supervisor of transportation for Koppers.

MARK K. WALLACH has established an automobile components manufacturing firm, the M. K. Wallach Accessories Automobiles in Chateauroux, Indre, France. Previously, he was chief industrial engineer with the Department of the Air Force in France.

The new concern will build aluminum wood-rimmed steering wheels for racing and sports cars, and small centrifugal superchargers. It has also programmed for special automotive induction systems and fuel injection.

JOSEPH M. NUNEZ is now a project test engineer, Government and Industrial Products Division, Studebaker-Packard Co. Previously, he was with the United States Army stationed at Fort Bliss, Texas.

CHESTER J. SELDEN has been appointed Midwest district sales manager, Silent Hoist and Crane Co., Inc. He had been supervisor, material handling engineering, Ford Division, Ford Motor Co.

L. W. OKON has been named manager, sales technical service, Deep Rock Division, Kerr-McGee Oil Industries, Inc., Cushing, Okla. Previously, he was manager, editorial, engineering department, Chek-Chart Corp.

FRANK P. GROSS, JR., previously a research engineer, Wood River Research Laboratory, Shell Oil Co., is now a design and development engineer with Shell Development Co., Houston, Texas.

A. R. OGSTON, formerly head of the Technical Service Division, Esso Export Corp., has been made technical consultant at Esso Export.

Ogston will specialize in the fuel and lubricants field. He has been associated with various Esso marketing affiliates for 20 years.

E. O. PETZOLD will succeed Ogston as head of the Technical Service Division of Esso Export's aviation department. Prior to this appointment, he was senior technical service engineer at Esso Export.

He has more than 25 years of company service in petroleum product research and technical service on aircraft engine, accessory, and airframe lubrication.

DONALD R. SKIDMORE has joined the Aircraft Division of Hughes Tool Co. as an aeronautical engineer. Previously, he was assistant manager, body engineering, Packard Division, Studebaker-Packard Corp.

CHARLES R. JOHNSON is now technical adviser, Shell Petroleum Ltd., London, England. He had been senior engineer with Shell Oil Co., in New York City. He will serve as adviser to the manager of the oil products department.

EVERT L. VENSTROM, who was supervisor of mechanical engineering for Twin Disc, is now assistant chief engineer, mechanical design at the Hydraulic Division.

MARVIN W. DUNDORE has been appointed assistant chief engineer, circuit design, Hydraulic Division. Previously, he was supervisor of circuit engineering.

CONRAD R. HILPERT, formerly a research engineer for Twin Disc, is now assistant chief engineer, research at the Hydraulic Division.

WILLIAM A. BLUME has been elected a vice-president of Ross Gear and Tool Co., Inc., and will be the general manager of the company's Gemmer Division. He had been vice-president in charge of sales for the Gemmer Mfg. Co. which recently merged with the Ross Gear and Tool Co., Inc.

C. F. HAMMOND, JR. has been appointed chief engineer, development section, for the combined companies. Previously, he was vice-president in charge of engineering for Gemer Mfg. Co.

KENNETH S. PALMER is now a product application engineer with Gates Rubber Co., Denver, Colo. He was chief product engineer with Hancock Mfg. Co. in Jackson, Mich.

LOUIS MORDA has been made aircraft engineering adviser, International Field Office, Civil Aeronautics Administration, Paris, France. Formerly, he was coordinating project engineer, Aircraft Engineering Division for the Civil Aeronautics Administration in Jamaica, N. Y.

He will assist countries in Europe when necessary concerning U. S. standards for certification of foreign built aircraft.

WILLIAM COURTNEY FILES is now a technical engineer, jet engine department, AGT Division, General Electric Co. Before joining General Electric, he was a project engineer, South Wind Division, Stewart-Warner Corp.

LEE WOOD has joined Westinghouse Electric Co. in Idaho Falls, Idaho as a planning engineer. He had been assistant mechanical superintendent at Peter Kiewit Sons Co., Longview, Wash.

FRANK W. BELINA, formerly a test engineer with Convair Division of General Dynamics Corp., is now a research and development assistant, Bombardment Missile Division, Wright-Patterson Air Force Base.

He will coordinate all aspects of contractor—USAF relations in dealing with SM-62 "Snark" missile program.

HOWARD A. DEETER, divisional comptroller of Pontiac Motor Division, General Motors Corp., has retired.

Deeter, who has been with General Motors for 35 years, held positions with International Silver Co., and National Conduit & Cable Co., prior to joining GM.

He became affiliated with Chevrolet Motor Division at Tarrytown N. Y., in 1921 as a supervisor. Later he served as assistant resident comptroller for Chevrolet at Buffalo and St. Louis, and in Detroit as office manager.

He went to Pontiac Motor Division as assistant comptroller in 1932 and in 1944 was made divisional comptroller.

CALVIN E. BAMFORD is now assistant manager, aluminum sales, Korhumel Steel and Aluminum Co., Evanston, Ill. Previously, he was a sales engineer for the Aluminum Co. of America.

R. R. KEARTON is now weapons system manager, Georgia Division, Lockheed Aircraft Corp. Prior to this appointment, he was director of administration for the division.

EDWARD J. CLARKE is now chief draftsman, Transmission Division, Clark Equipment Co. Formerly, he was with Utica Bend Corp.

CECIL M. BILLINGS is shown here with the satellite tracker he has just built for the Astronomy Department of the Franklin Institute in Philadelphia. It consists of a platform, an adjustable stanchion, and a leveling head. Frictionally connected to the leveling head are sliding bars carrying the adjustable platform for setting the binoculars in altitude from 0 to 90 deg. Binoculars are 7×50 special with 12 deg field. The chair and binocular platform can be rotated in azimuth 360 deg.

The instrument was designed to track the artificial satellites which the United States will launch into the upper air in 1957, the International Geophysical Year. But it's ready for use now, just in case the Russians beat us to it.

Billings was president of the Rittenhouse Astronomical Society of Philadelphia for 1954 and 1955. In April 1955 he presented the Rittenhouse Medal to Sir Harold Spencer Jones, Astronomer Royal of England.

Billings retired from the Gulf Oil Corp. at the end of 1954 after 20 years of service as an executive. He is living at 423 South Cedar Lane, Upper Darby, Pa.

LAWRENCE D. BELL, founder and president of Bell Aircraft Corp., has resigned as president and has been elected chairman of the board of directors.

Bell has been in the aviation field for the past 45 years. He founded Bell Aircraft in 1935.

JAMES R. PHELAN has joined Automotive Gear Works, Inc., subsidiary of Eaton Mfg. Co. as sales engineer.

Prior to joining Automotive Gear, Phelan was sales manager of Detroit Bevel Gear Co.

HENRY Y. RUBY has been named vice-president at Atlas Lift Truck Rental, Inc., Chicago. Previously, Ruby was a dealer for Chevrolet Motor Division, General Motors Corp.

ARTHUR G. WALDEN has joined Boeing Airplane Co. as a ground operations engineer. Previously, he was aircraft maintenance officer, 43rd Air Rescue Squadron, Department of the Air Force.

PATRICK R. MOORE, formerly an electrical engineer, missile operations, Chrysler Corp., is now a sales engineer with Larry Rachow Distributor.

He will be in charge of sales and also will act as technical adviser regarding water handling and conditioning equipment for the company.

JOSEPH L. VARGA has been made executive assistant at Republic Aviation Corp., Farmingdale, N. Y. Prior to this appointment, he was divisional manager for Ladish Co., Cudany, Wis.

RANDOLPH P. DOMINIC has been made account director, Communications Counselors, Inc., New York City. Prior to this appointment, he was associate editor, "Product Engineering," McGraw-Hill Publishing Co.

Dominic has served as National Aeronautics Meeting Publicity chairman and for the past two years has been field editor for SAE Metropolitan Section.

HERBERT L. MISCH has been named director of advanced product planning for Cadillac Motor Car Division of General Motors Corp. He had been chief engineer of the Packard Automotive Division with Studebaker-Packard Corp. He had been with Packard since 1941.

Continued on page 100

Obituaries

J. HOWARD PILE

J. Howard Pile, a past chairman of SAE Chicago Section and one of industry's best-known technical writers, died on Aug. 31, 1956.

At the time of his death, Pile was connected with the Book Department of Motor magazine. From 1918 to 1924, he was technical editor of Motor World, then a Class Journal Co. publication in New York. He had joined Motor World, after six years as associate editor of Automobile Trade Journal, then a Chilton publication, and a year as editor of Tractor & Trailer. Later he was associated with United Motor Service in New York. After leaving University of Pennsylvania, he had worked briefly for the Hall Gas Engine Co. in Philadelphia.

Pile joined SAE about the time he became editor of CHEK-CHART Corp. in Chicago in 1931. He was active in the work of the Chicago Section and served as its chairman in 1942–43. Subsequently he returned to New York as general manager of Fleet Owner, prior to purchase of that publication by McGraw-Hill Co.

J. E. BADLEY

J. E. Badley, founder and president of Tractor Training Service, Portland, Ore., died on June 19.

Badley entered the automotive industry in 1919 as service manager for the Cleveland Tractor Co. Distributors in Portland, Ore. In 1922 he joined Bear Tractor, Inc., of New York as western service supervisor. The following year he formed the Badley Truck Co. in Portland. From 1927 to 1932 he served as a western staff member for Caterpillar Tractor Co.

Badley formed the Angleworm Tractor Co. in 1933 and served as its president for the following four years. In 1937 he became president of Tractor Training Service, the position he held at the time of his death.

JOHN G. WOOD

John G. Wood, retired chief engineer, Chevrolet Division, General Motors Corp., died Oct. 3 at the age of 73.

Woods entered industry in 1907 with the National Motor Car Co. and later became chief engineer of the Empire Car Co. in Indianapolis. In 1913 he was made manager of the Remy Electric Co. of Anderson, Ind. During his five years there, the company became Delco-Remy Division of General Motors.

During World War I, he was in charge of an Indianapolis plant which turned out powerplants for the Army and Navy.

Following the war, Wood was made engineering director of Oldsmobile Division. Three years later he was appointed general manager of Muncie Products Division and two years after that he returned to Oldsmobile in charge of engineering.

In 1930 he was transferred to Chevrolet Division as an engineering executive, serving as chief engineer from 1945 to 1949. For a year after that, until his retirement in 1950, he was executive assistant to the general manager of the division.

Upon retirement,, he was called to Washington to serve on the Munitions Board under the Secretary of Defense. He left Washington in 1953 to become executive consultant of the New York Air Brake Co. and was elected a director in January, 1956.

Wood was a "gold card" member of SAE, having joined the Society of 1911.

PAUL J. RHOADS

Paul J. Rhoads, assistant chief engineer of the Detroit Transmission Division, General Motors Corp., died June 26 at La Pas, Mexico.

Rhoads joined Detroit Transmission as a laboratory assistant in the engineering department in 1942, after graduating from Ohio State University with a B.S. degree in mechanical engineering.

He was made project engineer in 1944, and in 1950 was advanced to senior experimental engineer. The following year, Rhoads became assistant superintendent of experimental engineering. In June, 1952, he was appointed assistant chief engineer of the division.

EDWIN B. MEISSNER

Edwin B. Meissner, president of the St. Louis Car Co., and a civic leader in St. Louis for many years, died Sept. 10. He was 71 years old.

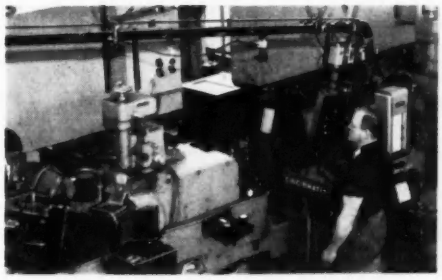
Meissner was also president of the St. Louis Mining and Milling Corp. of Joplin, Mo., and president of the St. Louis Aircraft Corp.

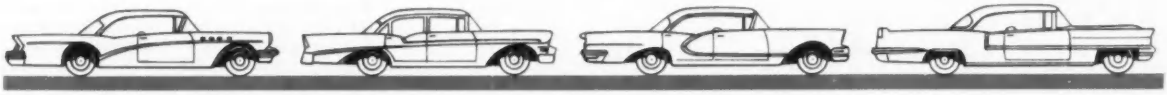
He helped to establish the Crime Commission in St. Louis in 1949 and was its president at the time of his death.

Meissner had been a member of SAE since 1939. He also served as vice-president of the St. Louis Board of Commissioners, as a trustee of the St. Louis Conference of Christians and Jews, and as a member of the president's council of St. Louis University.

ELECTRONIC GRINDING CONTROL

...one reason why we repeat:





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The photo above shows just one of many reasons why the HYATT Hy-Roll Taper Bearings we're building today are setting new standards of smooth performance. Batteries of these ultra-precision grinding machines, with the latest electronic controls, hold HYATT Tapers to tighter tolerances than ever possible before. In tapers, too, HYATT means *consistently high quality!* Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

GM GENERAL MOTORS

Watch "WIDE WIDE WORLD" Sundays on NBC-TV

HYATT HY-ROLL BEARINGS FOR CARS AND TRUCKS

About SAE Members

Continued from page 98

ROBERT G. HARDIN is now a sales engineer with Gulf Oil Corp. in Richmond, Va. Formerly he was a junior mechanical engineer at Gulf's Refinery Technology Laboratory in Philadelphia.

ROBERT B. WRIGHT, who had been a product development engineer with International Harvester Co., has joined Aerojet-General Corp. as a development engineer.

DONALD M. McDOWELL, formerly assistant chief engineer of Ingersoll Kalamazoo Division of Borg Warner Corp., has been appointed chief development engineer, Le Roi Division of Westinghouse Air Brake Co., Milwaukee, Wis.

it's your move!

WAUSAU

HAS THE INSERTS...

No. 2 Developed especially for die-cast aluminum alloy engines. Similar expansion characteristic holds seats tight in block.

No. 7 High chrome content hard seat for heavy duty gasoline engines. Economical, but high in impact and corrosion resistance.

No. 3 Premium quality cobalt tungsten chrome alloy for Diesel and gasoline engines. Dissipates heat, will not crack or loosen, high corrosion resistance, high impact resistance.

No. 1 Molybdenum alloy cast iron seat provides strength at low cost. Easily adaptable to air-cooled engines and tractors.

No. 4 Highest quality bi-metal seat. Standard of quality for almost every heavy duty engine application.

You can "move" in any direction in this line of valve seat inserts . . . choose from special alloyed cast iron, alloyed steel, bronze or bi-metal in flange, throat, threaded or conventional designs. Whichever way you "jump" you land safely with a valve seat proved in service by scores of leading engine builders who have specified Wausau inserts for many years. Metallurgical and design data on request.

WAUSAU MOTOR PARTS CO. • 2200 HARRISON ST. WAUSAU, WIS.

CHARLES W. SANFORD, formerly vice-president, manufacturing, Jack and Heintz, Inc., is now manager of overseas operations, International Division, AVCO Mfg. Corp. Sanford has been in the manufacturing industry for the past 23 years. Before joining Jack and Heintz as vice-president in 1952, he had been works manager for Whirlpool Corp.

BEN R. BENTSON is now field supervisor for Salt Lake City, General Electric Co. He was supervisor of design control, AGT Division, General Electric Co.

RAYMOND O. OYLER had been made assistant sales manager, Bristol plant, New Departure Division, General Motors Corp. He was manager, Midwest region, for New Departure.

PAUL M. CORP has been made president of Alliance Ware, Inc., Alliance, Ohio. Previously, Corp was vice-president and production manager at American Metal Products Co., Detroit.

JAMIL A. RAZZAK is now a tool engineer at Boeing Airplane Co. in Seattle. Previously, he was an engineer trainee with John Deere Waterloo Tractor Works, Waterloo, Iowa.

THOMAS G. TAXELIUS has joined the Bettis plant, atomic power research laboratory, which Westinghouse Electric Corp. operates in Pittsburgh for the Atomic Energy Commission. Formerly, Taxelius was a technical writer, Military Manuals Co., Renton, Wash. He will work as a technical writer on the atomic powered surface ship projects.

BENN D. KELLER is now technical assistant at the Arizona proving ground department of Ford Motor Co. Prior to joining Ford, he was manager, Packard proving ground, Studebaker-Packard Corp.

WILLIAM H. SHERWOOD has been made field promotion manager for the Aluminum Co. of America. He had been a sales development engineer for ALCOA.

DR. WILLIAM F. BALLHAUS, chief engineer for Northrop Aircraft, Inc., has been elected chairman of the Aircraft Industries Association's Guided Missile Committee.

J. C. PURCELL has been named manager, technical service, sales department, Chevrolet Motor Division, General Motors Corp. Prior to this appointment, he was with the field product section, engineering department at Chevrolet.

W. E. SCHMIDT has been appointed staff engineer in charge of production engineering activities in the assembly plants and field product engineering at Chevrolet. Previously, Schmidt was a resident engineer for the company.

Faster Fuel Pump Means Less Vapor Lock

(Continued from page 81)

reduction of the vapor-forming tendency has received attention in the past. When the relationship between these two characteristics is fully understood and the results applied to the improvement of fuel pump designs, the full potential of the diaphragm-type fuel pump may be achieved. (Paper "Automotive Fuel Pumps—A Fundamental Study of Their Performance" was presented at the SAE Summer Meeting, Atlantic City, June, 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N.Y. Price: 35¢ to members, 60¢ to nonmembers.)

Stock Car Racing Tells How Good We Aren't

Based on paper by

MAURI ROSE

Chevrolet Motor Division, General Motors Corp.

STOCK car racing challenges the automotive engineer to reduce the weight of all cars to provide better performance with the same horsepower, greater fuel economy, improved braking, reduced tire wear and general maintenance, as well as more safety through reduced loads on tires, shafts, and bearings.

Styling engineers are challenged to design front and especially rear wheel openings to permit easy change of tires and wheels. Why can't they style instrument panels so that gages can be read by the driver? Why can't fancy hood ornaments serve as bug deflectors?

Racing tells us that designers and engineers might produce a new rear-view mirror and place it where it doesn't dent the skull. They might devise a positive lock for divided front seat backs. Couldn't front seat brackets be incorporated in body frame mountings to give real safety? There's need, too, for hood locks that won't spring open and really good windshield wipers.

The chassis engineer is challenged to design gasoline tanks that don't spill the customer's money all over the ground. And don't forget the vent! There's need to control roll characteristics. Isn't there a better way than to use a stabilizer bar? Couldn't rear spring hangers be designed to remove rear wheel steer?

Electrical engineers should be able to locate the ignition coil or coil resistor in a low temperature spot to avoid malfunctioning of the ignition system.

Engine designers and test engineers are challenged by such questions as these: If your design and test of the head gasket was satisfactory, why do so many fail in racing? Is your fuel pump test run under realistic operating temperatures and speeds? And how about vapor lock? One size larger carburetor needle seat is equivalent approximately to getting 1 lb lower vapor pressure fuel. Who checked the production drawing tolerances and stack-up limits? Is that why the compression ratio is lower on the left bank than the right? How about valve float? It happens even in automatic transmission equipped cars if left in Lo-Drive to obtain top acceleration. A properly designed valve spring damper does wonders!

The production engineer is also challenged—to maintain good blending of all radii, to set up and maintain realistic production tolerances, to remove tool marks and rough edges on critically stressed parts, to strengthen met-

another good move...

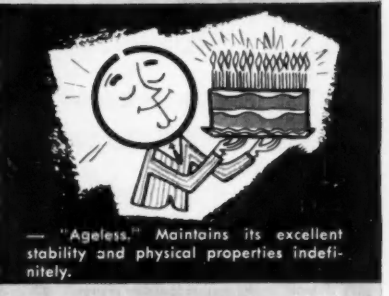
SPECIFY WAUSAU

HT-100, the "HE-MAN" COMPRESSION RING

— Withstands prolonged engine heat without loss of tension.

— 27% greater impact resistance than ordinary compression rings.

— Very high modulus of elasticity.



— "Ageless." Maintains its excellent stability and physical properties indefinitely.

— Laughs at fatigue, wear and breakage.

For heavy duty commercial vehicles and engines subjected to heavy work loads under difficult operating conditions . . . this is the ring you want. Produced from an exclusive alloy formula HT-100 is a "he-man" of a ring . . . a "brute for punishment" . . . able to function effectively under almost unbelievable conditions. Remarkably tough yet "smooth as silk" HT-100 reduces cylinder wear while at the same time sealing effectively. Write for Technical Bulletin #100.

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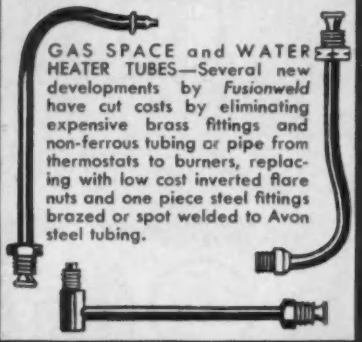
TUBING AIDS by *Fusionweld*

Spark Solutions to Production Problems

HEATING ELEMENTS—*Fusionweld* thin-wall tubing is widely used by manufacturers of electrical appliances containing low temperature calrod heating elements, such as electric irons, cookers, fryers, hot water heaters, etc.

OIL LEVEL INDICATOR TUBES—Avon's low cost, high production fabrication and forming of steel tubing with new spot welding technique in attaching brackets, clips or fittings to *Fusionweld* thin-wall tubing has been widely adopted by most motor car manufacturers.

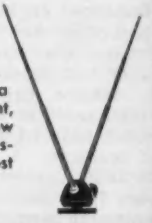
TUBULAR PUSH RODS—A current automotive development replacing solid steel push rods with *Fusionweld* steel tubing. These have swaged ends or hardened steel inserts (spot welded) in tubing ends. A high degree of concentricity is maintained with maximum run-out held to .020.



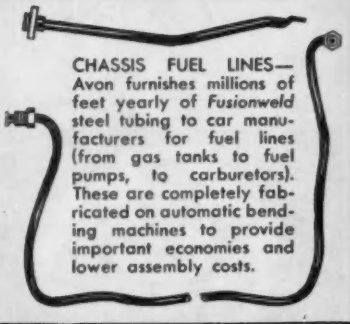
GAS SPACE and WATER HEATER TUBES—Several new developments by *Fusionweld* have cut costs by eliminating expensive brass fittings and non-ferrous tubing or pipe from thermostats to burners, replacing with low cost inverted flare nuts and one piece steel fittings brazed or spot welded to Avon steel tubing.

ENGINE OIL FILTER TUBES—For both internal and external use with brazed fittings attached. *Fusionweld* tubing can be beaded, swaged and sheared to meet specifications of motor car, truck and tractor manufacturers.

MISCELLANEOUS APPLICATIONS—*Fusionweld* thin-wall tubing is extensively used by toy manufacturers, umbrella and TV antenna makers, also for electric light fixtures, tubular furniture, etc. *Fusionweld* offers a tough, light weight, extremely ductile, low cost steel tubing easily formed for most requirements.



OIL SPACE and WATER HEATER TUBES—*Fussionweld* thin-wall tubing provide manufacturers of this and similar equipment with smart economies by replacing non-ferrous tubing and fittings with special steel fittings combined with *Fusion weld* steel tubing.



CHASSIS FUEL LINES—Avon furnishes millions of feet yearly of *Fusionweld* steel tubing to car manufacturers for fuel lines (from gas tanks to fuel pumps, to carburetors). These are completely fabricated on automatic bending machines to provide important economies and lower assembly costs.

Our latest tubing catalog mailed on request. Let us quote on random or cut to length sizes—3/16 O.D. to 3/4 O.D.—plain or terne coated—or fabricated and formed to blueprint specifications.

AVON TUBE DIVISION
HIGBIE MANUFACTURING CO.
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allurgical control, and to remove all foreign material from castings and completed engines. (Paper "The Challenge of Stock Car Racing to the Automotive Engineer" was presented at SAE Pittsburgh Section Meeting, May 16, 1956. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

group list of 18 items to make certain nothing is overlooked. Totaling the weights of all the groups gives an overall weight estimate. From this we can tell management how close we think we can come to the size and weight of vehicle they think they want.

Estimated weight makes possible forecasting total cost and that's most important. It can be used also to calculate forces to be placed on the wheels during various running and braking conditions. And it tells our engineers, among other things, the power and strength of structure they are going to need. (Paper "How a Car is Born" was presented at SAE Northern California Section, South Bay Division Meeting, April 1956. It is available in full in multilith form from SAE Special Publications Department, 485 Lexington Avenue, New York 17, N.Y. Price: 35¢ to members, 60¢ to nonmembers.)

Variety of Weapons Systems Needed

Based on talk by

LT.-GEN. J. M. GAVIN
Chief of Research and Development
Department of the Army

WEAPONS systems exist only to serve policy. Our government's policy implies need for a variety of weapons systems including a diversity of aircraft.

We have and will continue to need missiles that can destroy any operational aircraft in existence. At the same time, we need transports that will fly low and slow—slow at least during in the landing phase.

We may need an even greater range of aircraft in the future. Our greatest potential for survival lies in tactical innovation. And innovations often call for new equipment.

(This abridgment is based on a talk entitled "Technical Trends in Research and Development" given at a luncheon held during the SAE National Aeronautic Meeting and Production Forum, Los Angeles, October, 1956.)

Weight at Birth Key to Car Design

Based on paper by

A. G. SPEAR
Ford Motor Co.

ONCE top management has set targets for price, weight, size and performance of a new model, our engineers calculate weights just as aircraft engineers do. They locate the center of gravity by averaging the sums of the weights and their moments from a common forward point.

The weight information used is obtained from analyses made by our vehicle test group. Each item or group is allocated its carefully considered weight, then this weight is checked against a "uniform parts classification"

for today's "power-loaded" engines...
BORG AND BECK
CLUTCHES
MAXIMUM PERFORMANCE
MINIMUM MAINTENANCE
Through advanced design and creative engineering, BORG & BECK has stepped up the capacity of its passenger car clutches without increasing their over-all dimensions. Compact, light in weight, precision built—for maximum performance, minimum maintenance.
for that vital spot
where power takes hold of the load
BORG & BECK CLUTCH
THE STANDARD
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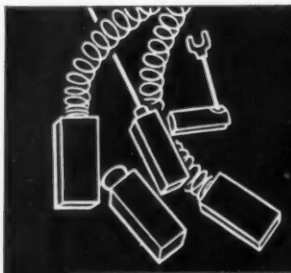


Brushes—

One of the world's largest lines, with grades for every type of earth-surface or high-altitude motorized electrical equipment . . . for all operating conditions.

. . . backed by over half a century's "know-how" in making carbon-graphite and metallic powder parts that perform the way you want them to!

Contacts

Contact improvement in a given application is seldom a matter of switching to new, more costly materials. More often, as Stackpole engineering has proved, it is only a matter of using contacts produced with the "know-how" of imparting a maximum of desirable characteristics to conventional materials, at the same time minimizing any inherent disadvantages.

STACKPOLE

STACKPOLE CARBON COMPANY, St. Marys, Pa.

Weapon Systems Challenge Industry

Based on paper by

WALLACE E. REESE

Northrop Aircraft, Inc.

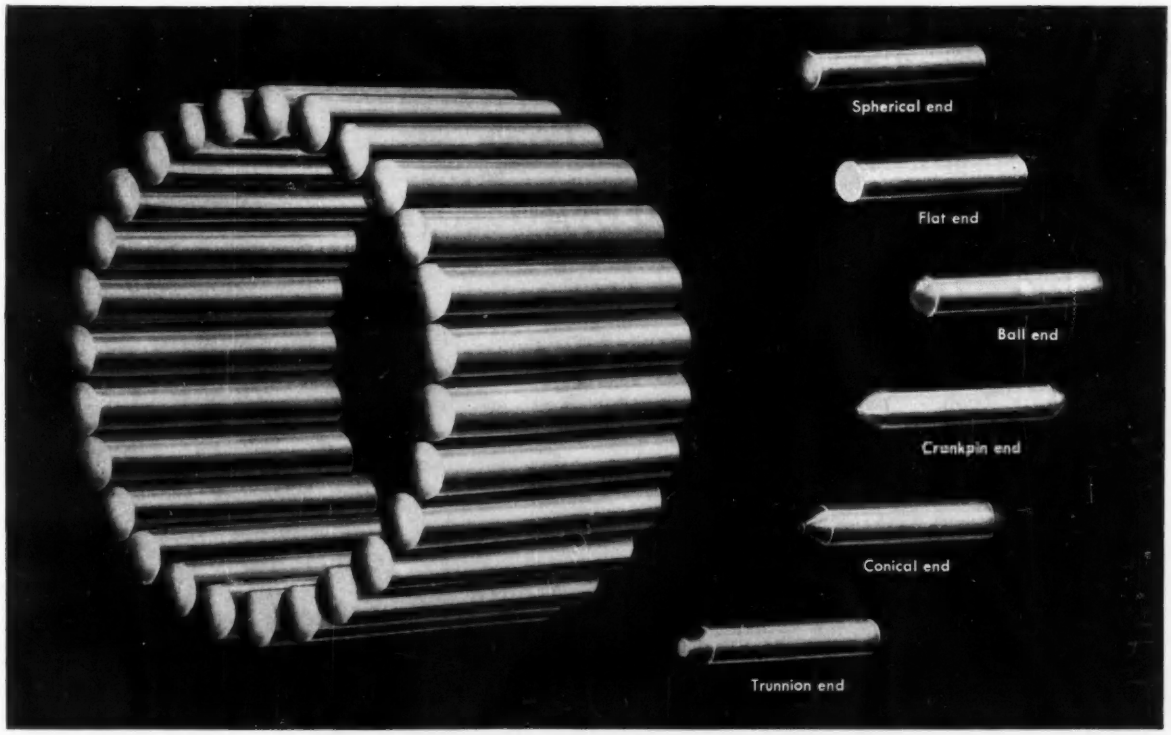
DEVELOPMENT of adequate ground operations must be started in the early phases of weapon design. Those concerned with evaluating operations should recommend features to ease the manpower, logistics, maintenance and ground support equipment load to get better maintenance, hence higher availability.

Need for Compromises

Compromises have to be made in all areas during weapon development and it is essential that these be analysed in relation to their effect on the other elements in the system. The time required to develop a sound, logical plan is proportionate to the size of the project. There is no rule of thumb other than to take time to do the job and refuse to be stampeded into making quick decisions. It is difficult enough to be planning for future operation when everyone else is worried about the release of drawings for the prototype article. All factors in a weapon system are equally important and deserving of more than a passing thought.

Ground operations planning will assume greater significance as the need for the human operator in manned vehicles becomes less important. Even now all operations in a pure missile system except actual flight are done on the ground, while the flight objective itself is determined by a human being prior to launching. Hence, the success of a campaign depends directly upon the capabilities of the men responsible for the weapon's ultimate effectiveness. If these men are not given the equipment, supplies, training, facilities and proper maintenance procedures in addition to the general operational employment techniques, the country will have failed in its obligation to foresee the problems and difficulties in putting its new weapons to work.

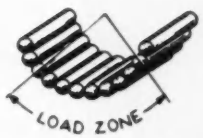
If new weapons do not work as they should and can, we will not gain a stalemate with any enemy; we will succumb as other great nations have done in the past. Development of weapon systems presents one of the most challenging problems to industry and the Armed Forces. Ground operations planning will help meet this challenge. (Paper "The Role of Ground Operations in a Weapon System" was presented at SAE National Aeronautic Meeting, Los Angeles, October 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)



TORRINGTON Needle Rollers

for the ultimate in load capacity at low cost

High radial capacity in minimum space stems from full complement of small-diameter rollers. Load zone contains maximum number of contact lines.



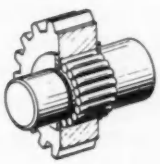
Fine finish contributes to efficient anti-friction performance. Needle Rollers are usually polished to 4-6 rms, but finishes as fine as 1-3 are available on special order.

High carbon chrome steel is carefully hardened, ground and lapped to make each Needle Roller a precision part for long-life performance.

Torrington Needle Rollers provide the lowest cost, highest capacity anti-friction bearings obtainable. They are manufactured in a complete line to meet SAE and AFBMA specifications. Available in the inexpensive spherical end type or in other end shapes, they provide maximum retainment and fillet clearances or greater lip retainment. Needle Roller standards for material, heat treat, tolerance and finish are the highest in the industry.

Close tolerances on Needle Rollers are assured by stringent quality controls. Standard OD tolerance is .0002" but rollers can be supplied with OD tolerance of .00005." Tolerance on length dimension depends on end formation.

Good operating results with Needle Rollers require careful design of mating parts furnished by the user. The Engineering Department of The Torrington Company, with broad experience in applications of Needle Rollers, will be glad to give you technical advice on your needs.



Mounted without races between hardened shaft and hardened housing (RC-60 recommended), Needle Rollers allow largest possible shaft diameters.

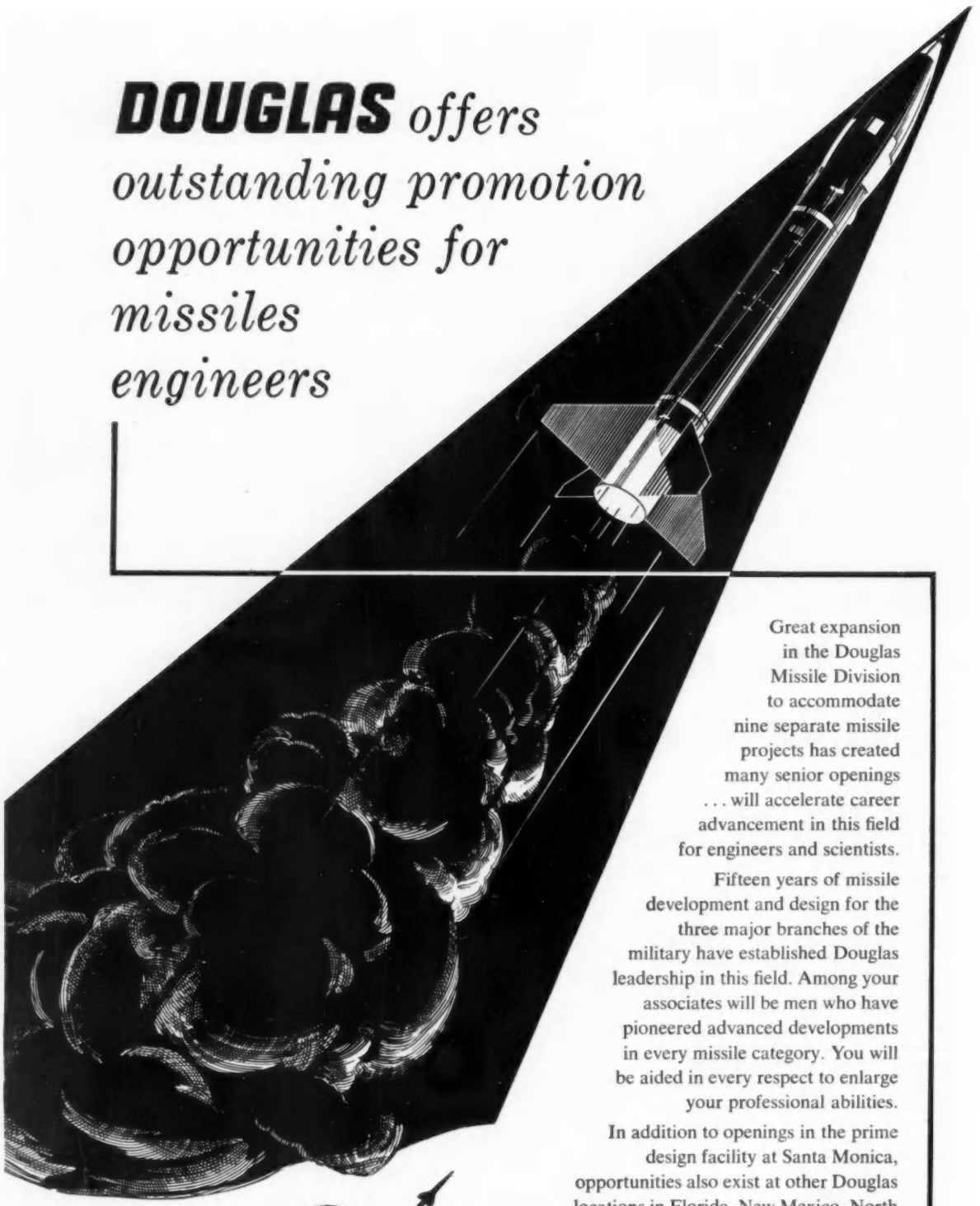
THE TORRINGTON COMPANY
Torrington, Conn. · South Bend 21, Ind.

District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

DOUGLAS *offers outstanding promotion opportunities for missiles engineers*



Great expansion in the Douglas Missile Division to accommodate nine separate missile projects has created many senior openings . . . will accelerate career advancement in this field for engineers and scientists.

Fifteen years of missile development and design for the three major branches of the military have established Douglas leadership in this field. Among your associates will be men who have pioneered advanced developments in every missile category. You will be aided in every respect to enlarge your professional abilities.

In addition to openings in the prime design facility at Santa Monica, opportunities also exist at other Douglas locations in Florida, New Mexico, North Carolina and California.

MISSILES BY **DOUGLAS**

For a personal interview, contact E. C. Kaliher, Missiles Engineering Personnel Manager, Box 620-O Douglas Aircraft Company Santa Monica, California

First in Aviation

Tubeless Tire Boon to Earthmovers

Based on paper by

W. P. MacKUSICK
Goodyear Tire and Rubber Co.

WIDE base, tubeless, off-the-road tires on sealed rims have given excellent results under test. Here are the advantages this type of tire offers earthmoving equipment:

1. Freedom from tube and flap troubles. (In many off-the-road operations, as much as 90% of vehicle down time for tire trouble is because of tubes and flaps. Reliable sources indicate that 6% of all vehicle down time is because of tires; so, if we eliminate tubes and flaps, there is a possible 5% increase in vehicle availability, to say nothing of the cost.)

2. Cooler running due to thinner assembly and better heat dissipation through rim. (Heat is one of the biggest enemies of tires, and is becoming more and more of a factor in off-the-road work with loads, speeds, and length of haul always on the increase. A cooler tire also means slower tread wear.)

3. Easier to handle in factory and field. Double inflation to remove tube stresses and flap wrinkles is eliminated.

4. Small injuries, which could lead to blow-outs of tube tires, result only in slow leaks.

5. Repairs can be made before costly and dangerous damage is done.

6. Cost of tube replacement is eliminated.

There are disadvantages and certain things to keep in mind. These are:

1. Tire beads must not be scuffed-up or slow leaks may develop. Bead base and bead-seat band must not be mutilated or distorted. Distortion may make easy assembly, and mutilation of the groove for the "O" ring may cause failure to seal.

2. It is necessary to catch the seal of the beads when mounting the tire in order to hold the air pressure. There will be times when the assembly won't hold air, especially when the operator is inexperienced, and when the tire is cured to a rim width smaller than the one on which it is being mounted. To overcome this difficulty one should have a device for restricting the tire outside diameter, which can be a flat metal belly band and a means for pulling the ends together. Chains, ropes, and cables have been used in emergencies, but these are difficult to handle and dangerous because the band tends to roll out of position when force is applied.

3. Valves must be applied properly and be tight enough to seal. Always check the valve first if there is a slow leak.

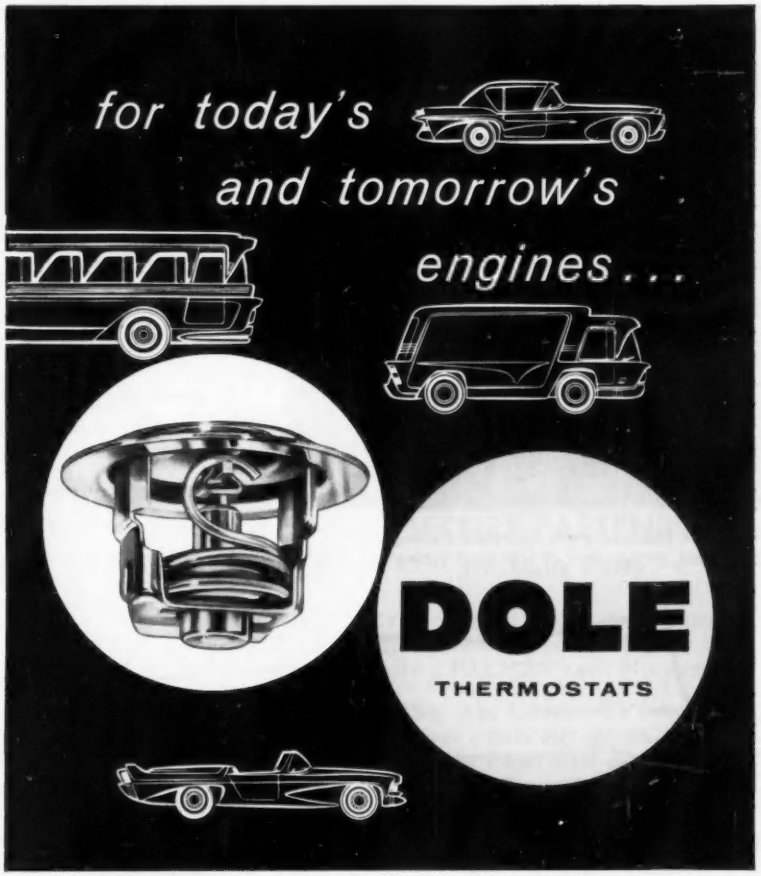
(Paper "The Wide Base Tubeless Tire" was presented at SAE National Tractor Meeting, Milwaukee, September 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Vibration Tester Handles Large Units

Based on paper by

W. C. SCHREYER
and
KENNETH B. YOST
Northrop Aircraft, Inc.

AN electro-hydraulic test facility to impose the vibration environment on large complex specimens has been developed at Northrop. The final



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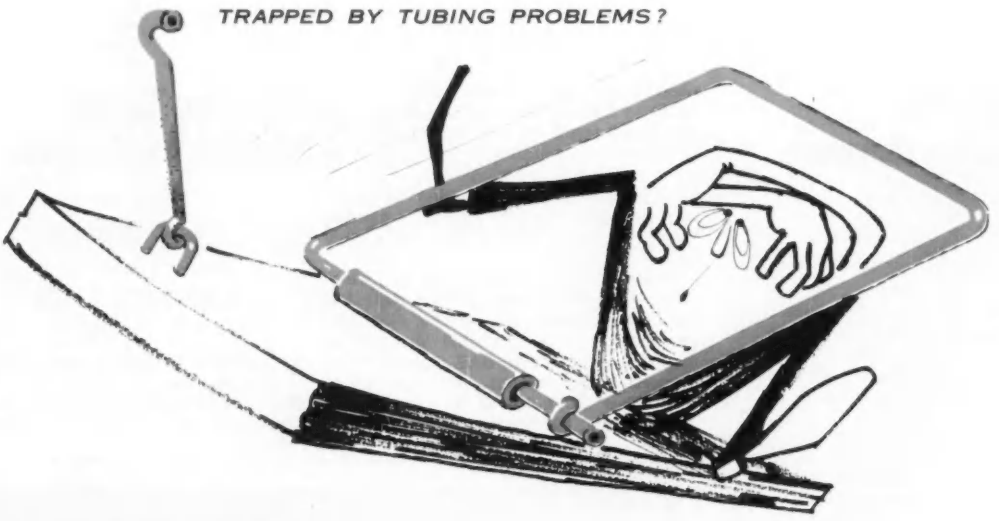

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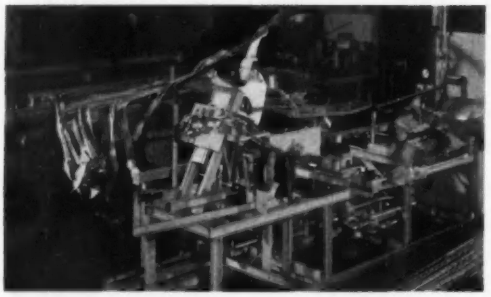

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group of test apparatus constitutes one of the larger types of vibration-output equipment in existence, although its full capacities remain to be developed.

The Electro-Hydraulic Vibration Exciter Facility, as it is known, has a peak blocked force output of 23,400 lb, operating under hydraulic pressure of 3000 psi. It has been tailor-made and adjusted to operate within the frequency range of 5 to 600 cps and has a total displacement of 0.25 in. double amplitude. Although tailored to fit a specific test requirement, the unit has a demonstrated frequency response up to 2000 cps.

The primary components of the facility are a hydraulic power package consisting of a cylinder, servo valves and voice coil, hydraulic power supply and electronic control equipment.

The power package consists of a voice coil driving a subminiature valve spool which meters oil to either end of the main hydraulic servo valve, in this case moving as a piston. Position of the main servo valve determines direction and quantity of oil flow to the hydraulic output cylinder. Appropriate characteristics are fed back through a servo loop to the electronic controls. The unit has been changed locally and redesigned as required during the development program.

The hydraulic power supply comprises a conventional pump, reservoir, accumulator, filters, and other standard hydraulic system components.

The electronic control system, while regarded as separate from the facility, is intimately tied to the power package. Much of the circuitry is designed specifically to compensate and correct the characteristics of the power package and to gain the maximum in frequency response.

A force of 55g has been produced with a 1200-lb specimen at advanced pressures and under experimental conditions. However, as a test facility operable on a day-to-day basis through a frequency spectrum of 5 to 600 cps, the shaker has cycled a 1200-lb total mass at an averaged measured force to the specimen of 15g.

Operation of this unit as a facility has revealed some distinct advantages:

1. The unit is not surrounded by a large magnetic field which must be degaussed for sensitive electronic test specimens. Alleviation of harmful magnetic fields has been found difficult to do.

2. The great rigidity of the components parts, the simplicity of design, and small number of moving parts gives the facility a high degree of utilization.

3. Overload causes no damage.

In addition to the vibration exciter, the facility requires jigs, fixtures, and structure to suit the particular specimen. Design considerations in preparation of this subsidiary apparatus is frequently as critical as design of the test specimen. It is exposed to the same vibration environment as the specimen, yet must have far greater structural integrity and resistance to vibration. Moving parts should be designed in such manner that all natural frequencies are above those occurring in the test spectrum. Consideration should also be given to the use of material with high modulus of elasticity, high internal damping, and low density. Manganese-copper alloy, a recent product, shows great promise, although there has not yet been practical experience with it.

Detail parts which generally are required and classed as subsidiary moving structure are:

1. A mechanical fuse to absorb misalignment between shaker piston and horizontal table. A near-perfect table would obviate this need.

2. A horizontal table or specimen holding structure which transmits the applied g acceleration directly to the specimen.

3. Flexures or leaf springs having the

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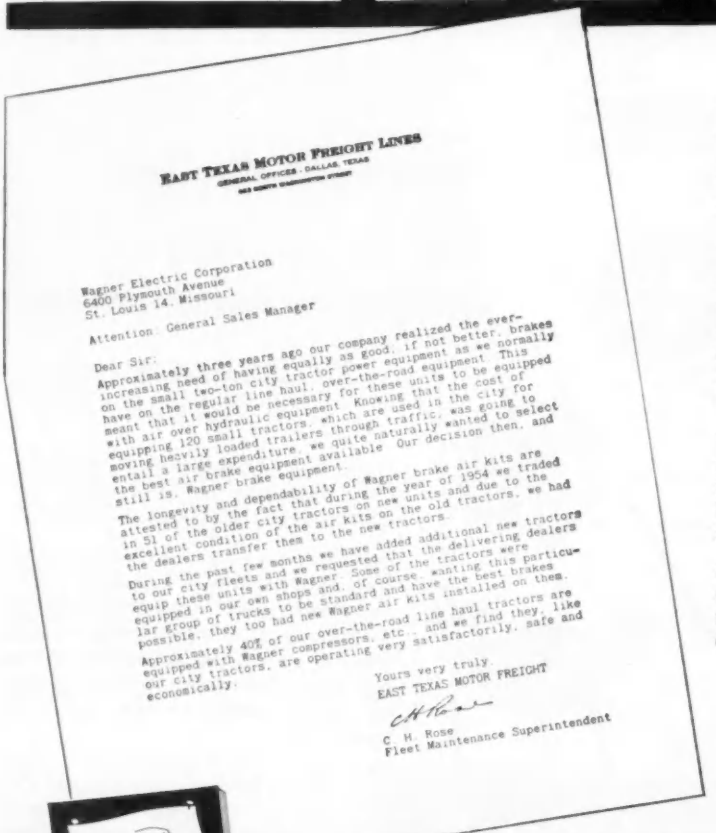
says: C. H. Rose, Fleet Maintenance Superintendent East Texas Motor Freight Lines, Dallas, Texas



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Wagner Electric Corporation
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Attention: General Sales Manager

Dear Sir:

Approximately three years ago our company realized the ever-increasing need of having equally as good, if not better, brakes on the small two-ton city tractor power equipment as we normally have on the regular line haul, over-the-road equipment. This meant that it would be necessary for these units to be equipped with air over hydraulic equipment. Knowing that the cost of equipping 120 small tractors, which are used in the city for moving heavily loaded trailers through traffic, was going to entail a large expenditure, we quite naturally wanted to select the best air brake equipment available. Our decision then, and still is, Wagner brake equipment.

The longevity and dependability of Wagner brake air kits are attested to by the fact that during the year of 1954 we traded in 51 of the older city tractors on new units and due to the excellent condition of the air kits on the old tractors, we had the dealers transfer them to the new tractors.

During the past few months we have added additional new tractors to our city fleets and we requested that the delivering dealers equip these units with Wagner. Some of the tractors were equipped in our own shops and, of course, wanting this particular group of trucks to be standard and have the best brakes possible, they too had new Wagner air kits installed on them.

Approximately 40% of our over-the-road line haul tractors are equipped with Wagner compressors, etc., and we find they, like our city tractors, are operating very satisfactorily, safe and economically.

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C. H. Rose
Fleet Maintenance Superintendent

The experience of East Texas Motor Freight Lines with Wagner Air Brakes is not unique. It is similar in many ways to the experiences of hundreds of fleet operators all over the country. It is concrete evidence that when you equip the units you manufacture with Wagner Air Brakes, you'll be providing the very best braking system available.

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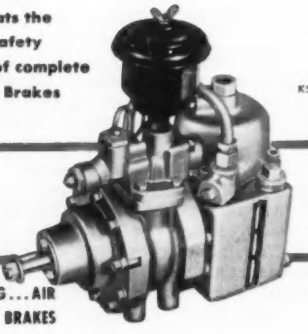

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dual purpose of supporting the combined specimen and table weight and limiting motion in the plane perpendicular to the input motion.

These parts that are also required in the vibration facility and are generally classified as static, reaction block, and flexure support, must also receive careful design consideration. They support the moving parts, hence it is essential to provide the maximum resistance to motion. For example, with the reaction block at 600 cps and 40*g* acceleration, the total excursion of the specimen is 0.0025 in. A reasonable displacement tolerance at the specimen is ±10%, which demonstrates that a motion of 0.00025 in. in the support structure is the maximum allowable. If the specimen weight is presumed to be 1200 lb at an oscillating load of 40*g* acceleration, the total force would be 48,000 lb. Massive structure with large damping characteristics is required to meet these conditions.

The facility has been in constant use at Northrop for approximately one year. During this time a more refined tool has evolved. Many problems have been found, some have been solved, some alleviated, and a few require added study and work. (Paper "Vibration-Testing Techniques for Large Specimens" was presented at SAE National Aeronautic Meeting, Los Angeles, October 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Car Air Conditioners Lower RVP Limits

Based on paper by

M. R. MORROW
Humble Oil & Refining Co.

THE ability of cars to handle higher volatility fuels has been increasing steadily, but the use of power accessories makes further improvements more difficult. Air conditioners cause particular concern because large amounts of heat are added to the engine via condensers which interfere, themselves, with the cooling system.

To determine the magnitude of the problem, road tests were conducted with 12 cars representing seven makes. The cars were unmodified except to install a drain cock in the fuel drain outlet of the gasoline tank. They were run for at least 20 miles at 60 mph, parked and idled for three minutes, and the engine stopped for 20 min to heat soak. Any hesitation or engine roughness was recorded as vapor lock.

Findings were that the RVP limits dropped 0.7 on the average when the units were turned on. For three cars tested before and after installation of the units, the RVP limits dropped 1.3 on the average when the units were installed but not operated, and dropped an additional 0.6 RVP when the units were turned on. (The drop of 1.3 RVP on installation may not be representative since the three units were of the same make.)

The fact that difficulties can be encountered even when units are not in operation indicates the importance of considering fuel volatilities for all seasons of the year. Another finding, that RVP limits for late model cars were relatively high, as would be expected for low mileage cars, suggests as a corrective the routine replacement of such worn parts as fuel pumps. (Paper "Automotive Air Conditioners and Gasoline Volatility Requirements" was presented at SAE Summer Meeting, Atlantic City, June, 1956. It is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion

R. I. Potter, Ford Motor Co.

The problem of volatility and vapor handling does exist and will continue. It is important to the committees of both the Coordinating Research Council and the American Society for Testing Materials studying it, and they should give emphasis and direction to this work. A set of standardized reference fuels might be established for evaluating vapor handling capacities of vehicles, both with and without air conditioning equipment, under adverse, high-temperature operating conditions. A common yardstick is needed, not a textbook.

Careful consideration should be given to facts and figures, such as the author has presented, in the composition of gasolines to prevent intensification of the problem. The invention of a vapor handling additive for suppression of high vapor pressure fuels would be most welcome at this time.

J. E. Taylor, Gulf Research & Development Co.

We question the procedure of basing the volatility tolerance of a vehicle on the volatility of the fuel in the tank at the time of vapor lock. Although this is a technically sound approach from the standpoint of the fuel system's ability to handle or expel gasoline vapors, it does not answer the fuel suppliers' major question—"What Reid Vapor Pressure can we supply to the customer without getting vapor lock complaints?" Since fuels generally weather in the tank, the volatility of tank samples is lower than that of the fuel originally charged to the tank. Our data indicate the difference can be as much as 2 lb RVP.

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High Speed Limits Ram Air for Cooling

Based on paper by

A. R. PERL

and

J. HALL HOOD

Convair Division, General Dynamics Corp.

AT high speeds and high altitudes it becomes impractical to use ram air for cooling equipment. A heat sink must be provided and water seems to be the best material to use.

At low speeds, where the ram air temperature is considerably lower than the limiting temperature of the item being cooled, a ram air heat exchanger will suffice to transfer the heat to the atmosphere.

In the next range of speed the process can be extended by using a device, such as a turbine, to expand and cool the ram air to a usable temperature level. In theory, if the ram air could be recovered and expanded with 100% efficiency it could be returned to its initial ambient static temperature and thus used for cooling at any Mach number. In practice, however, the ram recovery losses and turbine inefficiency limit the maximum speed at which the process is effective. For example, at Mach 3.0, assuming a total pressure recovery of 70% and a turbine efficiency of 70%, the temperature of the expanded ram air would be 180 F, which is too high for effective cooling at our assumed equipment temperature level.

Beyond this point it is possible to devise more complex processes which would enable heat to be rejected to the atmosphere. For instance, if the ram air were compressed further to a higher temperature, a heat exchanger could then be used, but it would have to be extremely large to minimize pressure loss, and a heavy multistage turbine would be needed to expand the air efficiently at the high pressure ratio. Of greater significance is the fact that irrespective of the process a point is reached where it is not feasible to cool the ram air down because the cost in terms of momentum drag and equipment weight becomes prohibitive.

The answer to the problem lies in providing a heat sink within the aircraft. Water seems to be the most effective and convenient material for a stored capacity. Hydrocarbon fuel cannot serve the purpose because of its

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low absorption of heat during evaporation (approximately 15% that of water).

With stored water as a heat sink it is possible to use an open cycle air cooling system. Undoubtedly it will have limited applications in certain speed ranges because of its simplicity. In general, where efficiency for long duration at supersonic speed is important, water should be used in conjunction with a closed cycle cooling system. Essentially, this means installing the equipment to be cooled within sealed compartments and recirculating the cooling medium continuously in a closed circuit.

By substituting ram air for the water at lower flight speeds, the system could be optimized for both subsonic and supersonic flight operation. Consideration would be given to pressurizing the system to reduce the air handling equipment. However make-up air for leakage must be reduced to a minimum because of the excessive penalty paid for taking high temperature air into the system. (Paper "Air Conditioning and Pressurization Equipment Requirements for High Performance Flight" was presented at SAE National Aeronautic Meeting, Los Angeles, October 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Polar Flight Fine While You Stay Aloft

Based on paper by

KNUT JONN

Scandinavian Airlines System

IT isn't the low ambient air temperatures while flying that create trouble in trans-polar flight, it's the combination of very low temperatures and strong winds met during ground stops. Aircraft are subjected to these extremely low temperatures for longer stretches on the polar route than they are on other routes.

The propeller auto-feathering system has given trouble. On some occasions it has reacted too slowly when checked before take-off, because of a lag in the auto-feather switch at the bmep transmitter on the engine nose section due to the increased viscosity of cold oil in this part of the engine. A certain sluggishness in bmep-indication was also noticed frequently in flight under extreme cold weather conditions. To avoid this trouble, the transmitters have been protected with an insulating material.

Sometimes the high viscosity of cold oil in the propeller system makes reversing difficult. To insure positive and quick propeller reaction, crews have been instructed to change the rpm a couple of times before landing. Then, to insure circulation of warm oil out into the propeller dome, the propeller system has been modified and domes are provided with permanent insulating hoods. Special shields are used to cover the opening in the engine cowling lest strong winds cool the engines excessively during ground stops.

Water system lines froze frequently during the first winter of polar flying. To overcome the trouble, water lines located close to the skin have been moved and in some places flexible lines have been installed. Additional valves have been provided to permit leaving the filling lines empty after ground servicing.

The air conditioning system has been another source of trouble. Various modifications are being made to eliminate "nuisance drop-outs" of the cabin heaters. The limit of the overheat thermo-switch has been increased somewhat, a new type of cycling switch with better contact material has been installed, and the overhead fuses have been relocated for accessibility during flight.

A plenum chamber has been incorporated in the combustion air intake to prevent snow and rain entering the cabin heater. To permit operating the cabin heater while fueling on the ground, special spark arresters are fitted to the cabin heater exhaust. Under conditions of extreme cold, it may be necessary to use a special ground heater to keep the cabin warm. (Paper "Problems of Trans-Polar Operations" was presented at SAE National Aeronautic Meeting, Los Angeles, October 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Seating for Comfort Becomes a Science

Based on report by

F. C. MATTHAEI, JR.

American Metal Products Co.

SEAT adjusters have a long history but the multipositioning type of desired quality could not be produced at a price warranting production until 1953. Adjusters with a 5 in. fore and

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aft travel, combined with a 2 in. vertical travel, satisfy most seat requirements. Both power and manually operated adjusters now are in wide use.

The simple, conventional topper pads appearing in large quantities in 1955 represented the start of modern rubber seat padding development. These pads were generally about 1-½ in. thick. Full depth rubber padding for backs is now up to 7 in. in thickness. Current production pads are a combination of material and synthetic foam rubber.

Polyurethane padding has great possibilities, but is not yet ready for use. Contours can only be obtained on one side of the material, and humidity and aging problems still exist—though recent formulations are improving the physical characteristics. Indications are that polyurethane pad can be made equal or slightly under the present cost of foam rubber padding. Polyester chemicals promise to solve all seating requirements, but cost approximately twice as much as polyurethane.

The individual spring in a seat spring assembly is tested for its free and loaded contours, then checked for fatigue life. Free contours are measured with finger templates located to body inch lines. Loaded contours are obtained by positioning either a seated dummy, or separate back and cushion saddles in the seat.

A common criterion for cushion testing established by one major automobile producer is 280 in.-lb of work from the static to the extreme deflected position of the seat cushion. For testing fatigue life, 65,000 cycles at this figure is considered an adequate ordeal. Seat back spring assemblies are often overdesigned in respect to fatigue to assure close enough spring spacing to give adequate pad support and minimum wrinkling.

(This article is based on the secretary's report of panel on developments in seating held at SAE Summer Meeting, Atlantic City, June, 1956. Panel leader was E. C. Pickard, Ford Motor Co.; secretary, F. C. Matthaei, Jr., American Metal Products Co. Panel members were: W. J. Clark, Chrysler Corp.; J. G. Haviland, Fisher Body Division, General Motors Corp.; V. H. Hoehn, U. S. Rubber Co.; and L. B. Ragsdale, Ternstedt Division, General Motors Corp.)

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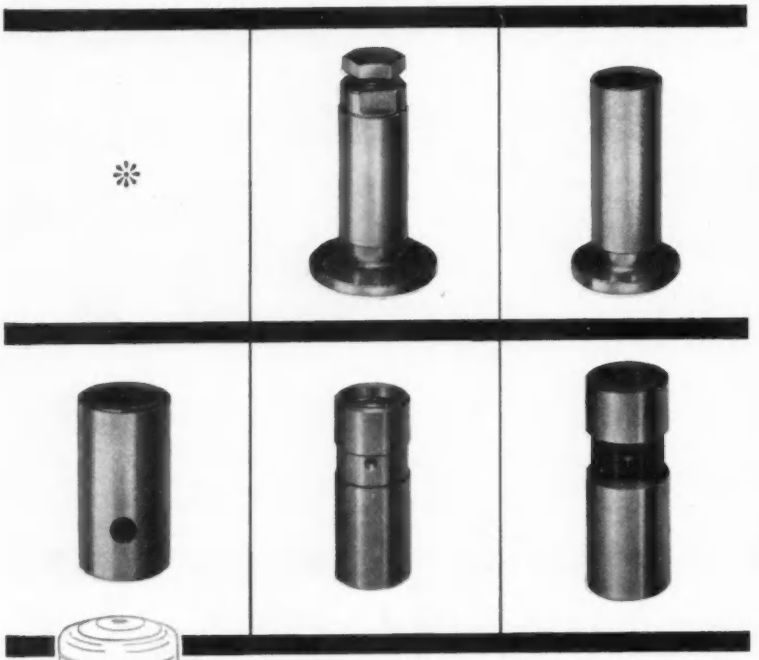

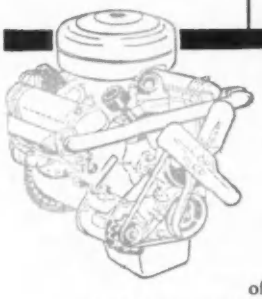

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Analyzing Pressure Control Valve on Servo

Based on paper by

R. R. BERLOT

The Ramo-Wooldridge Co.

ALTHOUGH pressure control valves are being used to overcome the effects of compliance between a hydraulic servo and its load, opinions regarding their performance and potentialities are far from unanimous. For this reason, an analysis has been undertaken of the pressure control system to give to the designer an understanding of its capabilities and limitations.

A study of the dynamics of the system involved setting up an analogue for the mechanical system. This was possible to do because the equation of continuity or conservation of current is identical in electricity and fluid dynamics. If pressure is taken to be analogous to voltage, and volume flow rate to be analogous to current, acoustical networks can be constructed to represent the hydro-mechanical system under study, and the familiar tech-

Something New in Piggyback

Shown here is a new semi-automatic hold-down device for securing highway trailers to flat cars in piggyback service. Developed by American Car and Foundry Division of ACF Industries in cooperation with the Pennsylvania Railroad and Rail-Trailer Company, this retractable trailer hitch moves up to brace the trailer in place, folds down flat to give clearance during loading.

ACF uses high-strength Mayari R plates to build this hitch, which is substantially stronger under impact than earlier types of braces. One man with a power tool can now secure a trailer in 2½ minutes, instead of the usual three-man crew requiring 5 minutes.

Because Mayari R has a higher yield point than carbon steels, it provides greater strength than carbon steel of the same section. Or it can be used in lighter sections to reduce deadweight. It has superior resistance to corrosion and abrasion, and good impact properties. It can be worked and welded as readily as other steels.

Catalog 353 contains detailed technical information about Mayari R, along with many interesting photographs and case histories covering a wide variety of applications. A copy will be sent you promptly upon request.

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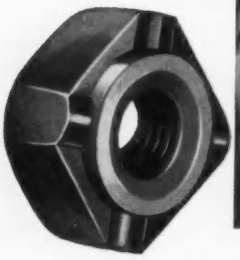

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niques of electrical network theory can be used to arrive at the dynamical equations of the system. These equations will be non-linear in general and will require the facilities of a computer for solution.

From the linearized analysis it can be concluded that the performance of the pressure control system is effectively independent of the compliance of the oil, also of the compliance in the linkage between actuator and load. Although this last compliance was not included in the analysis, it would appear in the electrical analogue as an additional capacitor in parallel with the inductance representing the load inertia. The analysis has shown that the pressure control valve behaves like a "voltage source", so that the current through the load inductance is independent of any impedance in parallel with it.

It is important to note that an unlimited oil supply is required for ideal behavior of the pressure control valve. This is so because the capitance in parallel with the load inductance will draw more and more current as its impedance drops with increasing frequency. At sufficiently high frequencies it will represent a negligible impedance path to ground. At this point the residual resistance in the voltage source, which up to now has been negligible with respect to the load impedance, becomes the largest impedance in the circuit. Then the valve begins to look like a current source instead of a voltage source, and the system characteristics approach those of a flow control system.

The effect of the vanishing load impedance and limited oil supply will be the limiting of the valve slider displacement. For any finite input signal there will be a frequency at which the load impedance, with the available oil supply, will be too small to produce the sufficient feedback pressure to stop the sliders before they hit the mechanical limits. The result of these effects will be the appearance of additional phase shift at a lower frequency than would be predicated by the equation for the ratio of flow through the actuator load and displacement of the pilot valve. However, the band width of the system should still be greater than for a flow control system, and it may be possible to extend it appreciably by having an accumulator at the oil input to the valve.

Since the pressure control system ideally is a double integrator, whereas the flow control system is a single integrator, it is, of course, necessary to supply an additional differentiation by electronic shaping or tachometer feedback if the pressure control servo is to be interchanged for the flow control system. (Paper "Analysis of a Hydraulic Servo Using a Pressure Control Valve" was presented at SAE National Aeronautic Meeting, Los Angeles, October 1956. It is available in full in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

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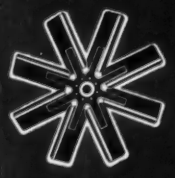

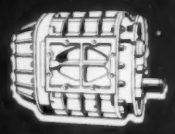

AT THE S. A. E.

1957 ANNUAL MEETING

SCHWITZER

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INDIANAPOLIS, INDIANA

Plan for Changes—Don't Fight Them Off

Based on report by

RALPH MEDROS
General Electric Co.

IT takes production planning to make a product available on time and this presupposes an objective and a program to carry it through. Make the plan reasonable in its requirements and consistent with available resources. Coordination in the use of resources and balanced accomplishment will be helped if each major segment of the organization sets up its own program in harmony with the master plan.

To check on performance, reports are needed frequently enough to prevent wide departure from the program, yet not be burdensome. Timeliness is important. Check progress versus the program periodically. If new action is needed, it should be directed toward rectifying causes rather than effects.

Design changes are an integral part of the aviation business so there is no point in fighting against them. Activity should be organized to process them in the most expeditious manner just as one would meet production schedules. Flight safety items should be given priority but other changes should be balanced against the following items before deciding on the time of their introduction: inventory, materials in process, retrofit requirements, maintenance and overhaul instruction publications, spare parts, tooling and testing equipment, cost conditions, the manufacturing process, the engineering need.

Some organizations have been trying out a project concept wherein components of the organization are given specific responsibilities in terms of the programmed objectives rather than simply to manage homogeneous functional groups. The extent of the organization ranges from the size of the project team to that of an entire project organization.

(This article is based on the secretary's report of Panel on Production Planning for Product Availability held as part of the Production Forum at the National Aeronautic Meeting and Production Forum, New York, April 1956. Panel leader was G. E. Fouch, General Electric Co.; secretary, Ralph Medros, General Electric Co. Panel members were: A. S. Frank, Grumman Aircraft Engineering Corp.; J. S. Mason, Glenn L. Martin Co.; C. H. Mitchell, Brig. Gen., USAF; S. C. Pace, Thompson Products, Inc.; M. C. Sarnes, Studebaker-Packard Corp.; E. A. Wright, North American, Inc. Report is available together with 6 other panel reports as SP-315 from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: $1.50 to members, $3.00 to nonmembers.)

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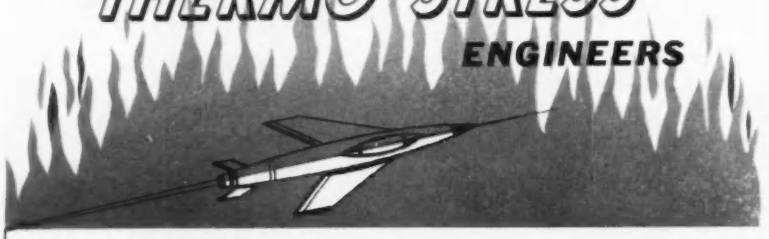

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Automatic Data Handling Applied to Stereo Camera

Based on talk by

W. C. McFADDEN
Hycon Mfg. Co.

CONSIDERING the fact that by aerial photography, we can bring a complete model of the terrain into the laboratory for measurement and observation, it seems entirely feasible to apply some of the newer techniques of data processing to this problem. We, among others, are marrying electronic scanning to the stereo camera with the planned extension to the use of computers and automatic recording of geophysical data and with the addition of

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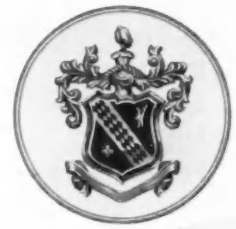

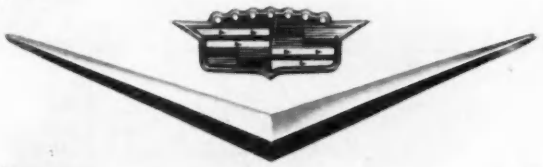

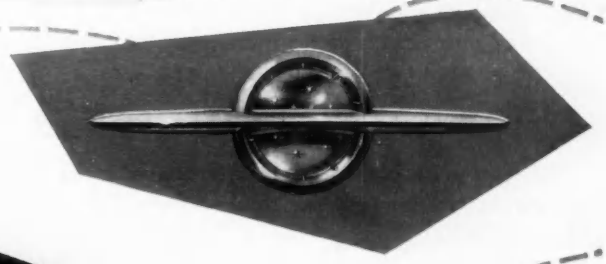

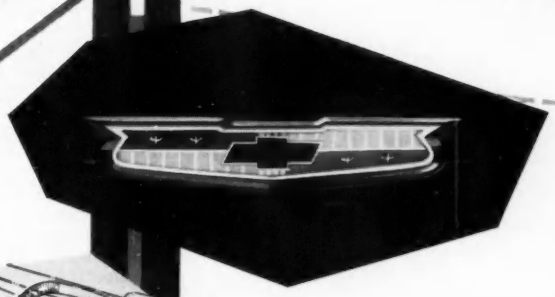

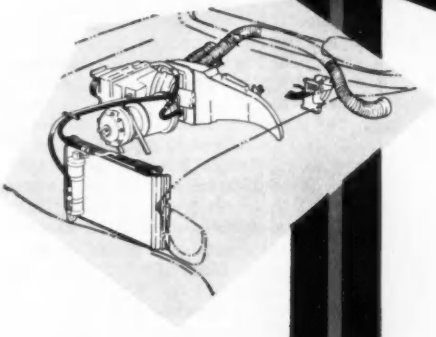

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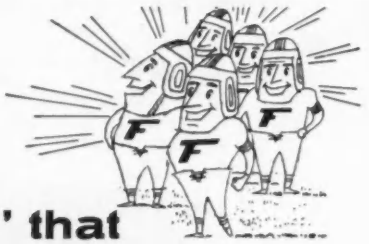
memory storage techniques and automatic print-outs as the ultimate solution.

However, many attempts are still being made to solve limited aerial reconnaissance data processing problems by existing machinery. Unfortunately, the photograph contains a tremendous amount of data which are not of the type that can be handled by ordinary data systems. The methods that have been used select the very limited information in the aerial photograph which can be entered into ordinary processing systems on the assumption that the other information is not necessary. Unfortunately, to date there is always something significant left out, and these techniques have not been too successful.

(This abridgment is based on a talk entitled "Reconnaissance—More than Meets the Eye" given at a luncheon held during the SAE National Aeronautic Meeting and Production Forum, Los Angeles, October, 1956.)

FASCO



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- LOW-PRESSURE INDICATING SWITCH
- SERIES "400" PRESSURE SWITCHES
- HEADLAMP SWITCH

Time was, when FASCO automotive components such as these were considered only as "extras." But they served their purpose so well and contributed so much to over-all performance and customer satisfaction—that one by one, they have been adopted as standard equipment by America's leading manufacturers of cars and trucks . . . a fine tribute to FASCO engineering skill and product dependability.

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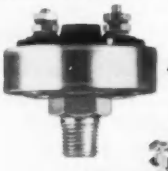
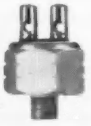
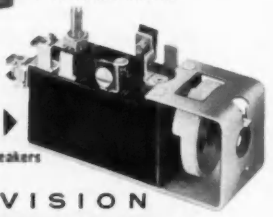


FASCO SERIES "400" PRESSURE SWITCH



FASCO HYDRAULIC STOPLIGHT SWITCH



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Grooving Aids Friction Materials

Based on paper and discussion

J. F. JOHNSON

AND

E. P. STEFL

Raybestos-Manhattan, Inc.

GROOVING of friction materials has important results other than the scavenging for which it is commonly used.

Besides eliminating oil from the friction surface at the time of engagement and thus increasing the clutch's coefficient of friction and torque capacity, grooving can:

- Give better cooling by providing means for a larger oil flow through the clutch (when wider and deeper grooves in a waffle-type pattern are used);
- Provide an oil thickness of more than a minimum level.

Within narrow limits friction can be controlled by changing the grooves made in the friction material to eliminate oil from the friction surface at the time of engagement. A difference of plus or minus .02 can be obtained by such variations. Though small, this value is large percentagewise when frictions of .06 to .09 are under consideration. Friction variations can be readily affected by change in land area up to the point at which durability decreases.

Cooling by means of wider and deeper grooves is getting more and more attention because higher horsepower engines are demanding increased torque from oil clutches. To prevent heat damage to the steel divider plates, every effort is being made to deliver the oil to the point where it will absorb the most heat.

Provision of more than minimum-level oil thickness is also of great importance. While wet friction practice can be said to be somewhere between dry friction and hydro-dynamic lubrication, its success in modern mechanism depends upon the maintenance of the minimum films of lubricating medium. Were it not for this film, the interface would approach dry conditions and friction would rise to an intolerable level.

Further improvements in wet friction operation can be effected through the study of theory and practice of grooving.

(Paper "Friction Materials for Automatic Transmissions" was presented at SAE Passenger Car, Body & Materials Meeting, Detroit, March 7, 1956. It is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members, 60¢ to nonmembers.)

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by matching the insertion method to the assembly problem

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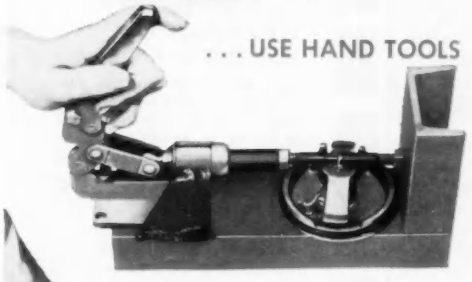

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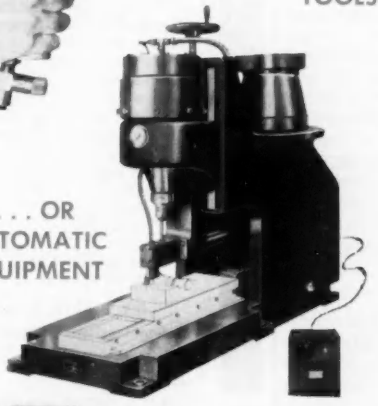

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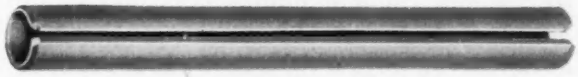
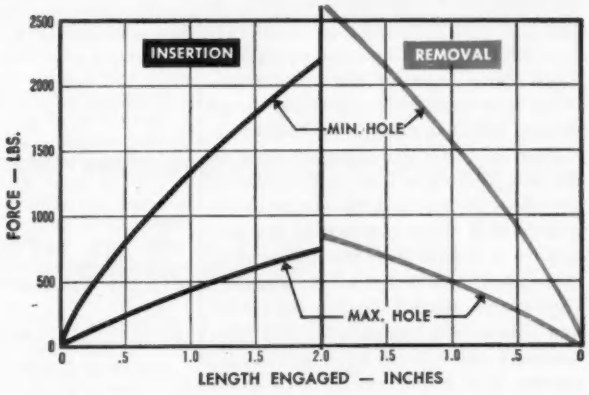
Rollpin is a slotted, chamfered, cylindrical spring pin. It locks securely in place—and can be drifted out and reused over and over again. Rollpin replaces taper pins, straight pins and set screws; for many applications it will serve as a rivet, dowel, hinge pin, cotter pin or stop pin.





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Based on paper by

HELMUT SCHLITT
Bell Aircraft Corp.

THEORETICAL knowledge and the system conceptions in the field of navigational instrumentation are ahead of what is technically feasible. This is demonstrated by our failure to produce and operate large system complexes with reliability, rather than by an inability to build any particular instrument as was once the case.

Barriers to Complete Automation

The problem of reliability and complexity is a barrier to complete automation and it must be overcome before there can be a decisive and successful approach to the goals set by the requirements of hypersonic aircraft and satellites.

These goals will have to be approached simultaneously from three directions. One approach is to recognize clearly present-day technical limitations, and evaluate projects to be undertaken not only by the number of black boxes to be developed, but also by consideration of the associated reliability aspects derived from existing equipment and extrapolated to future instrumentation.

This approach could lead to realistic expectations as to what can be accomplished within a given time period. If it is found technically not feasible to reach the goal within a certain time interval, prohibitive costs and later disappointment will be prevented. At the same time, this will contribute to a sound direction of efforts which ultimately will yield some optimum results.

Challenge

The second, and rather conventional, approach calls for improving the reliability of each individual component. This is a challenge to designers, test engineers, manufacturers, and military personnel, and to make it work requires a considerable educational effort directed at all personnel. This approach will probably not suffice by itself to solve the problem entirely because of the tendency for the systems under consideration to increase in complexity.

Must Combat Complexity

There is, however, one more possibility. It bases on the fact that high performance does not necessarily mean a high complexity. The third approach for overcoming the reliability barrier is, then, to apply every available technological means to combat complexity. This means more than to employ conventional technical means, it implies applying all significant technical advances in the fields of mechanics, electronics, physics and chemistry—the new technical areas represented by such items as semiconductor devices, transistors, new heat and cold resistant materials. These advances represent important steps toward this goal of reduced complexity which have to be followed by many others. (Paper "Technological Barriers to Progress in the Field of Navigational Instrumentation" was presented at SAE National Aeronautic Meeting, Los Angeles, October 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

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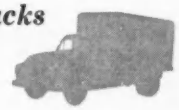
MR. DAVID G. REID
Engineering Personnel Mgr.

REPUBLIC AVIATION CORP.
Farmingdale, L. I., N. Y.

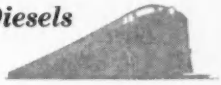
Passenger cars

Trucks

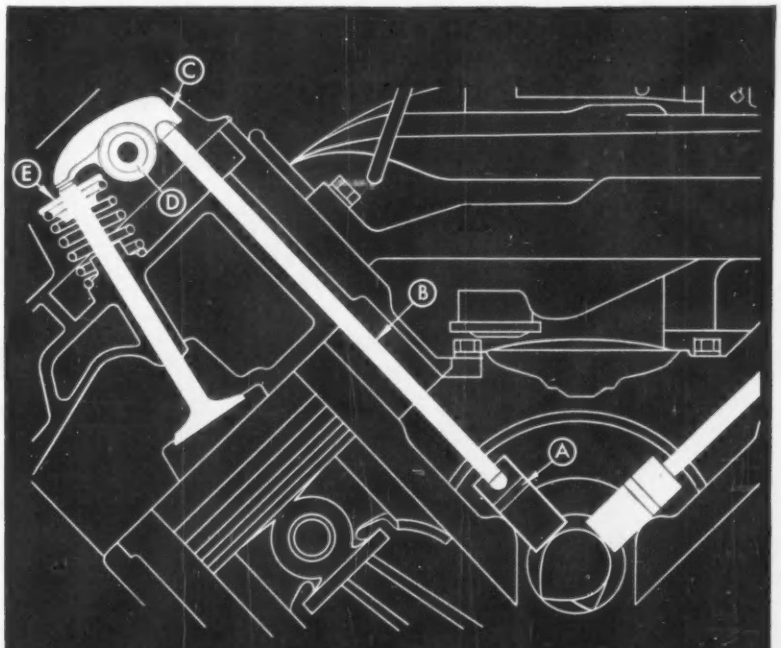


Tractors

Diesels



Aircraft



Chicago valve train parts in a typical V-8 automotive engine: (A) Hydraulic tappet, (B) push rod, (C) rocker arm, (D) rocker shaft, (E) valve spring retainer.

When it comes to valve gear, leading engine makers come to

CHICAGO

Here at Chicago you'll find a single source for everything you need in valve gear. These specialized facilities are solving problems and saving money for leading engine manufacturers . . . and can do the same for you.

Design and Engineering—at Chicago you'll find valve gear engineering experience in depth . . . men who understand your problems and will work with your engineering staff in designing cam shafts and complete valve gear assemblies for any type of engine.

Manufacturing—Chicago is a leading manufacturer of valve train parts. Our complete line includes precision-made hydraulic and mechanical tappets; push rods in both lightweight tubular and solid styles; valve adjusting screws including new self-locking screws that cut assembly costs; valve spring retainers; rocker arms and rocker shafts.

Testing—we have complete laboratory and engine testing facilities.

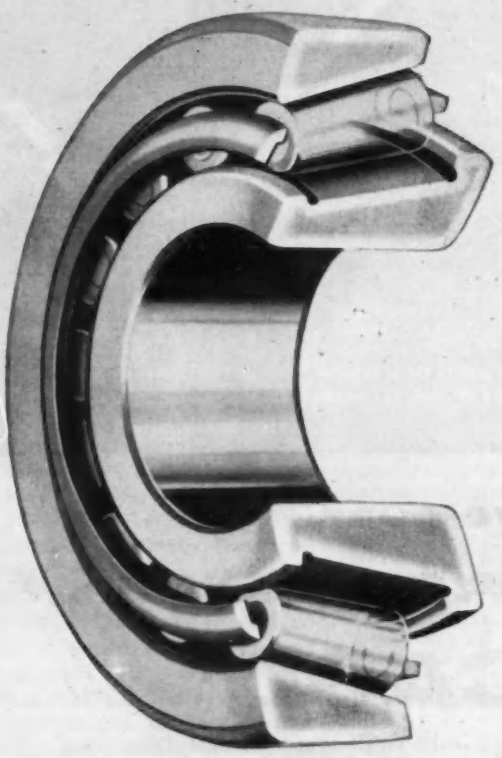
For the full story of how we can serve you, write our Tappet Division.

THE CHICAGO SCREW COMPANY

DIVISION OF STANDARD SCREW COMPANY • ESTABLISHED 1872

2521 WASHINGTON BOULEVARD, BELLWOOD, ILLINOIS

There's a BOWER TAPERED ROLLER BEARING engineered to fit your product



Types and sizes to fit a wide range of tapered bearing applications

There's no need to compromise with bearings! Whatever your product, if it uses tapered roller bearings, call in a Bower engineer for expert help on selecting the exact type and size you need.

Depending on your own particular needs, he'll make sure you get the exact size and type—selected from Bower's complete tapered line—engineered to assure maximum performance in your application.

Most important of all, when you specify Bower tapered roller bearings for your product, you get all the advantages of advanced Spher-O-Honed design—less maintenance, longer life, smoother operation. Get the full facts on the *complete* Bower line.

Tapered, Straight and Journal Roller Bearings for every field of transportation and industry

BOWER ROLLER BEARINGS

BOWER ROLLER BEARING DIVISION • *FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.*

New Members Qualified

These applicants qualified for admission to the Society between October 10, 1956 and November 10, 1956. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

Gerald E. Misel (M).

Baltimore Section

Arthur A. Kelly, Jr. (J), 2nd Lt. Frederick B. Metzger (J), Paul A. Miller (A).

British Columbia Section

Gordon M. Kirkham, (A), Abel Joseph Leger (M), Patrick H. Martin (A), Samuel John Scagel (M).

Buffalo Section

Raymond Deibel (M), Robert W. Lally (M).

Canadian Section

Robert Earl Bolton (M), Bradley Hall (J), Mokal G. Morgan (M), Alfred William Pelletier (A), Robert Williams Purcell (M), John Hans Tanzer (M), Joseph E. White (A), John D. Wood (M).

Central Illinois Section

William T. Fall (M), James Hamilton Lambie (M), Richard E. Masters (J), Surendrakumar P. Patel (J), Russell C. Pulst (J), Clifford H. Springer (M).

Chicago Section

Oscar E. Anderson (M), Fenton L. Bagley, Jr. (J), James F. Bueche (J), Leonard S. Burns (M), Ray P. Dunn (M), Avrum Gray (J), Paul C. Jones (J), Thomas R. Penisten (A), Loren G. Pless (J), Joseph E. Risser (J), Fred P. Robinson (M), Max Rosenberg (M), Chester Claude Shelton (A).

Cincinnati Section

Byron A. Nilsson (J), Richard C. Rossow (J).

Cleveland Section

Frank J. Bowser (M), W. C. Burton (A), Coyt R. Halverstadt (A), Douglas S. Jones (A), James F. Macholl (M),

LISLE Magnetic PLUGS
DRAIN PLUGS
Worth Looking into for Your Products!
BEFORE
AFTER
If you are looking for sure, low cost protection against excessive wear in your product, it will pay you to check the Lisle Magnetic Plug catalog. Interesting application data may suggest how you can benefit by using Lisle Magnetic Plugs in place of ordinary drain plugs in any gear case. "Before" and "after" views at left show how the powerful magnet in the Lisle Plug pulls abrasive metal particles out of the lubricant.
BOOTH #53
BOOTH #53
We'll see you at the SAE Engineering Display
LISLE Corporation
CLARINDA, IOWA

New Members Qualified

Continued

H. P. Rassbach (M), Arthur Thomas Reeves (A), Frank W. Sharman (J), Samuel L. Spooner, Jr. (J), Theron J. Thaden (M).

Dayton Section

Charley R. Aycock (A), John W. Carlisle (J), Frederic Brooks Doege (J).

Detroit Section

Roger M. Atherton, Jr. (J), James W. Atkinson (J), Patrick W. Baker (J), Joseph E. Beaudin (J), Herbert W. Behlow (J), Thomas G. Berry (J), John A. Berst (J), Kurt C. Binder (M), Lyle Marvin Blackwell (J), Raymond I. Bradley, Jr. (J), Robert William Brown (M), Roy A. Brown, Jr. (M), James R. Burns (M), Frederick W. Carr, Jr. (M), Theodore Cicero (M), Leon A. Corral (J), Norman B. Cox (J), John E. Curtis (A), Frank L. Dempsey, Jr. (A), Miles G. Doolittle (J), Robert H. Dougherty (M), Harold R. Droste (A), Alfred W. Duff (J), Michael Ference, Jr. (M), James E. Friant (J), Philip J. Garthe (J), William A. Gartland (J), Harold P. Gonyea (M), Oliver D. Hanna, Jr. (M), Theodore C. Hobbs (M), Frank B. Holmes (J), Robert A. Jackman (J), Donald J. Kiesgen (M), John Kloian, Jr. (J), Charles C. Krueger, Jr. (J), Leo A. Kudela (M), Henry Kummerfeld (A), Gerald M. Larson (J), Donald G. Lundin (J), Salvatore A. Manera (J), Hans A. Maurer (M), Ralph W. McCort (A), John W. McDermott (J), Jerome F. Meek (J), Robert R. Miller (J), William M. Miller (J), Bluford L. Moor, Jr. (J), William E. Pinkerton (A), William V. S. Rigby (A), William J. Ruby (M), Harold J. Schell (J), Peter J. Shuttleworth (J), Leo G. Steinl (J), Gerald J. Tobias (M), Phillip Jay Walcott (J), Lyle Richard Weiss (M), Howard E. Werner (J), Douglas J. Wing (J), Stanley W. Wolfe (J), Bernard F. Woods, Jr. (J), Wendell M. Young (M), Sanvus Yuen (J), Richard M. Zeek (J).

Indiana Section

George R. Anderson (A), William E. Freed (J), Frederick W. Kerby (J), Dwight R. Shumann (J), Clayton L. Smith (M), James H. Tarter (J).

Metropolitan Section

Charles A. Benson (M), Richard Edward Call (J), Victor T. Carbone (M), Robert J. Eden (A), Jules Gilbert (M), Richard L. Kline (J), Daniel S. Maisel (M), James John Manning (A), Edward Melinsky (J), William F. Morgan (M), Emil J. Novak (M), Kanumuru V. K. Raju (J), H. Joseph Schineller (J).

Mid-Michigan Section

Marion L. Davis (M), Earl H. Hogsten (M), Albert Macciomei (J), John G. Mezoff (M), Donald R. Reinertson (J), Robert S. Williams (A).

Milwaukee Section

Irving R. Christensen (A).

Montreal Section

Hugh William Douglas (A), Orrin M. Firth (A), A. S. Lowe (A), George Alan Perry (J), William George S. Thomas (M).

Depend on EUREKA RADIATORS
for RUGGED ENDURANCE & MAXIMUM COOLING

EUREKA

OVER 30 YEARS OF SPECIALIZATION

For over 30 years, EUREKA Cores and Radiators have served the automotive industry with utmost dependability. Our facilities, equipment, and personnel are available for your needs. We welcome the opportunity of integrating our specialized skills with your needs to help you achieve a well-planned production schedule.

What are your requirements? We can build Radiators to your order in any type, to any size or shape. Send us your blueprints for prompt quotations!

EUREKA RADIATORS AND CORES
for CARS, TRUCKS, TRACTORS and SPECIAL APPLICATIONS.

AUTO RADIATOR Manufacturing Co.
Guaranteed Radiator Cores Since 1915
2901-17 INDIANA AVE. • CHICAGO 16, ILLINOIS

In Engineering,

the best opportunities

are in Aviation.

In aviation,

the best opportunities

are at Temco.

AIRCRAFT CORPORATION • DALLAS

SUPERVISORY POSITIONS:

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SENIOR ENGINEERS:

Design, Metallurgy
Weights, Structures
Structures Test, Aerodynamics

Write: Joe Russell,
Engineering Personnel, Dept. 170-E,
Temco Aircraft Corporation,
Box 6191, Dallas, Texas

New Members Qualified

Continued

New England Section

Charles J. Bry, Jr (A), Donald S. Lee (J).

Northern California Section

Neo Corsini (M), Jack W. Ehlen (J), Edwin R. Hanson (J), Lt. Alfred L. Jones, Jr. (J), Dean Schallen (J).

Northwest Section

Joseph D. Weatherstone (J).

Oregon Section

Rollin W. Fishwood (M), Edward J. Salata (A).

Philadelphia Section

Alexander H. DuPuy (M), John H. Hopkins (M), Eugene Joseph Karlik (A), Jerome B. Koch (J), George F. Sharrard (M), Russell E. Warmkessel (M).

Pittsburgh Section

Joseph A. Juhas (J), Alexander L. Madyda (J), S. Allen Oviatt (M).

St. Louis Section

Allen H. Baker (J).

San Diego Section

Paul R. Shipps (M).

Southern California Section

James Emley Ahl (J), Charles Richard Banter (J), Dale R. Burger (J), William J. Candler (M), James F. Cullinane (J), Don Edward Ehrlich (J), Robert Emerzian (J), Don W. Geri (J), Robert G. Getrost (J), Wesley Philip Harris (M), Collis H. Holladay, Jr. (J), Paul T. Hughes (M), Frederick L. Spafford, Jr. (M).

Southern New England Section

Hubert Neal Allen (J), John E. Godown (J), Thomas W. Hubbell (J).

Texas Section

John S. Mead (M), George W. Vollmer (J).

Twin City Section

Paul Robert Dyste (M).

Virginia Section

2nd Lt. Ellis A. Schmidt (J), Robert Lee Wilkinson (M).

Washington Section

Sidney Frye Williams, Jr. (M).

Outside Section Territory

David C. Howard, Jr. (J), Jim Leon Marshall (J), John W. Richard, Jr. (J), Richard H. Swartz (M), Alan C. Tracy (M).

Foreign

John S. Drylie (M), Australia; Karlheinz Ern (M), Germany; B. Cyril Fernando (M), Ceylon; Miguel Salles-Berges (J), Mexico; Joseph Wright (M), England.

ROCKFORD

New!

Air-Flow

Heavy-Duty • Over-Center Clutch —with MORLIFE® Clutch Plate

This *new* AIR-FLOW type clutch was designed to provide unusual air cooling qualities. Increased torque capacity is obtained with the Morlife clutch plate. Levers are counterbalanced to eliminate self-engaging tendencies, when the clutch is idling. An unique spring-loaded feature greatly reduces frequency of adjustment. For information how this *new* Rockford AIR-FLOW clutch, with Morlife plate, will improve the operation and increase the on-the-job hours of your heavy-duty machines, write—

"MORLIFE clutch has gone 851 hours without slipping or adjustment."

"MORLIFE clutch going strong after 1695 hours, working in sand."

"MORLIFE clutches last 950 hours longer, without adjustment."

"MORLIFE clutch needs adjustment once a month, instead of daily."

"MORLIFE requires lighter handle pull and one tenth the adjustments."

"MORLIFE pulls harder and lasts six to ten times longer."

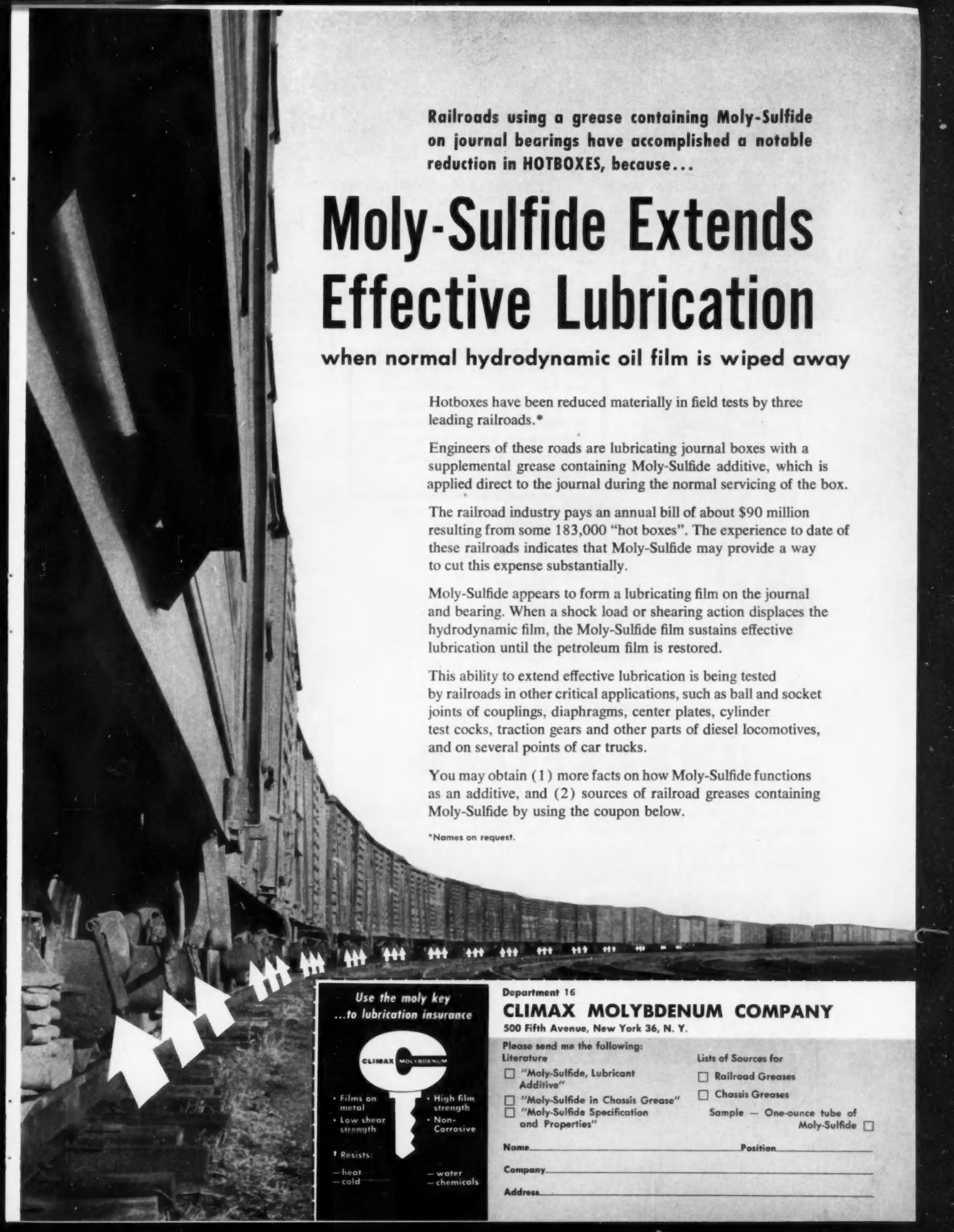
"Won't buy a unit that isn't equipped with Durable MORLIFE clutch."

ROCKFORD Clutch Division BORG-WARNER

316 Catherine Street, Rockford, Illinois, U.S.A.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

CLUTCHES



Railroads using a grease containing Moly-Sulfide on journal bearings have accomplished a notable reduction in HOTBOXES, because...

Moly-Sulfide Extends Effective Lubrication

when normal hydrodynamic oil film is wiped away

Hotboxes have been reduced materially in field tests by three leading railroads.*

Engineers of these roads are lubricating journal boxes with a supplemental grease containing Moly-Sulfide additive, which is applied direct to the journal during the normal servicing of the box.

The railroad industry pays an annual bill of about $90 million resulting from some 183,000 "hot boxes". The experience to date of these railroads indicates that Moly-Sulfide may provide a way to cut this expense substantially.

Moly-Sulfide appears to form a lubricating film on the journal and bearing. When a shock load or shearing action displaces the hydrodynamic film, the Moly-Sulfide film sustains effective lubrication until the petroleum film is restored.

This ability to extend effective lubrication is being tested by railroads in other critical applications, such as ball and socket joints of couplings, diaphragms, center plates, cylinder test cocks, traction gears and other parts of diesel locomotives, and on several points of car trucks.

You may obtain (1) more facts on how Moly-Sulfide functions as an additive, and (2) sources of railroad greases containing Moly-Sulfide by using the coupon below.

*Names on request.

Use the moly key ...to lubrication insurance

CLIMAX MOLYBDENUM

- Films on metal
- Low shear strength
- High film strength
- Non-Corrosive

† Resists:

— heat
— cold
— water
— chemicals

Department 16

CLIMAX MOLYBDENUM COMPANY

500 Fifth Avenue, New York 36, N. Y.

Please send me the following:

Literature

- ☐ "Moly-Sulfide, Lubricant Additive"
- ☐ "Moly-Sulfide in Chassis Grease"
- ☐ "Moly-Sulfide Specification and Properties"

Lists of Sources for

- ☐ Railroad Greases
- ☐ Chassis Greases

Sample — One-ounce tube of Moly-Sulfide ☐

Name _____ Position _____

Company _____

Address _____

Applications Received

The applications for membership received between October 10, 1956 and November 10, 1956 are listed below.

Atlanta Section

Norman D. Burns, J. O. Holt, James H. Maxey.

Baltimore Section

Wesley M. Jester.

Buffalo Section

William D. Huston, Lawrence W. Jones, John W. Kershaw, William V. O'Neill.

Canadian Section

Robert M. Buchanan, Ronald E. Lister, John D. Nasmith.

Central Illinois Section

Robert S. Bloomfield, David J. Gant, Dean E. Hilst, Arthur L. Jameson, Gordon W. Johnson, Edwin J. Kirk, Allan G. Marr, Joseph V. Miller, William H. Olson, Jr., Clyde L. Pritchard, Ralph Lee Sisler, Roger Allen Stapf, Howard E. Ward, Richard B. Warren, Norman C. Zeter.

Chicago Section

John R. Battalora, William K. Biery, Michael A. Chaszeyka, Frank C. Edwards, Allan E. Fitzpatrick, William A. Hodges, Edward R. Hodgman, Jr., Ray Edward Koskie, Gordon D. McKittrick, Norman G. Olsen, Francis W. Smiley, Peter J. Sorensen, G. Townsend Underhill, Lloyd F. Wenker.

Cincinnati Section

Claude G. Franklin, N. F. Frischhertz, Jack M. Mitchell, Joseph C. Stewart, Fred L. Sumser, Peter R. Tolley.

Cleveland Section

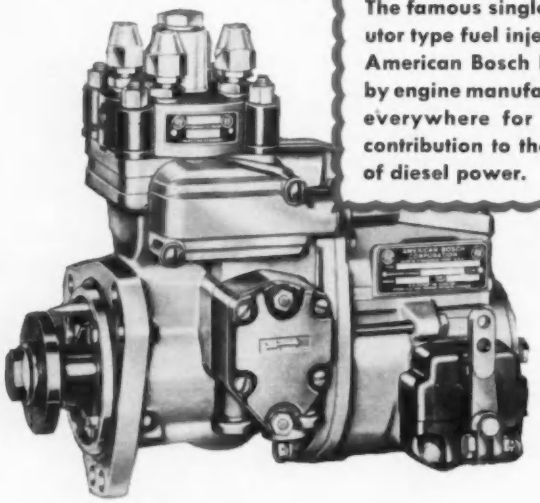
Otto A. Ahlegian, Judson T. Bennett, William C. Blunt, Robert J. Broadwell, William A. Campbell, Eugene D. Cowlin, Donald A. Gustafson, Lars U. Hedlund, Philip A. Kubik, Edmund Lis, Forrest L. McCracken, Samuel J. Oakes, William G. Richardson, William J. Smith, Jr., David J. Stevenson, John M. Washburn, III.

Detroit Section

Stanley S. Baibak, Donald D. Ballard, Eugene J. Barney, Charles V. Bliven, W. Kenneth Bodger, Robert W. Broberg, David J. Burkhardt, John R. Christenson, David L. Cohoe, Jr., John Cory, Gene O. Cowie, Kenneth N. Donelson, Robert M. Dwyer, H. Bernard Ernst, Frank E. Field, Charles H. Fletcher, Jr., Ravender Nath Gheyee, J. L. Gilliam, Robert E. Harvie, John A. Holm, Frank H. Horstman, Benjamin T. Howes, Peter R. Juk, Ronald William Kind, Frank L. Kittle, Jr., James D. Mallory, Anthony W. Markhauser, John J. McAllister, Walter S. McPhail, Ivan N. Momtchiloff, Ernest A. Parkanzky, Alex M. Pentland, Charles A. Pfister, Richard L. Reynolds, James R. Ritzema, J. J. Roberson, Neil M. Romeo, John V. Ryan, Carl E. Schmitter, Morton E. Sewell, Joseph J. Simone, Allen Clark Smith, Myron E. Stanton, Robert W. Stapleton, Donald I. Streck, Elmer C. Stringham, Ernest A. Tsakiris, Kenneth W. Van Dyke, J. Kenneth Williams, Stuart P. Weckerly, Frank W. Wilson, Frank S. Zukowski.

Hawaii Section

Ralph E. Fuller, Norman Gerner,



The famous single-plunger distributor type fuel injection pump—the American Bosch PSB—recognized by engine manufacturers and users everywhere for its outstanding contribution to the expanding use of diesel power.

the PSB fuel injection pump

UNEXCELLED

. . . for performance and outstanding service—that's the acknowledged record of more than 100,000 American Bosch PSB pumps now in use.

Here's some reasons why! Simple construction . . . fewer parts . . . accurate fuel metering and distribution . . . positive governor control . . . replaceable hydraulic head for fast field servicing.

What's more—all American Bosch fuel injection products are backed by a growing system of authorized service agencies, fully equipped to provide quick, efficient repair service.

Unequaled value—for top diesel engine performance and economy of operation . . . long trouble-free life . . . lower maintenance expense—nothing equals a PSB fuel injection pump.

AMERICAN BOSCH

AMERICAN BOSCH

Division of

American Bosch Arma Corporation

Springfield 7, Mass., U. S. A.

New equipment, expanded departments, added technical personnel and increased productivity all help to make Long your ideal "production partner."

But you'll discover Long's real plus factors in our management-engineering team. Its talent for creating high quality products with economical design and volume manufacturing advantages is your biggest profit potential.

LONG-BUILT TRACTOR RADIATORS GIVE TOP PERFORMANCE

Tractor engines need specialized cooling to do the best possible job. Leading tractor manufacturers specify Long-built radiators because they are rugged and dependable; *because they are engineered for the best performance under the severest field requirements.*

Since 1903 Long has been engineering and building high quality heat exchangers for industry. Whatever the type of fuel used, your engine cooling can be improved. Ask us for help on *your* problem.

LONG B-W BORG-WARNER

LONG®

LONG MANUFACTURING DIVISION, BORG-WARNER CORPORATION
12501 DeQuindre Street, Detroit 12, Michigan
Also: Oakville, Ontario, Canada
Export Sales: Borg-Warner International, 36 South Wabash St., Chicago 3, Illinois

THE STANDARD OF QUALITY AND PERFORMANCE SINCE 1903

FIGHT VIBRATION WITH VIBRATION

Shaker system for complex motion tests

NEWEST TECHNIQUE in environmental testing is complex motion testing. It comes closest to reproducing actual vibrational environments encountered in operation of missiles, aircraft, vehicles.

An MB Vibration Exciter System designed for such service is one of optimum versatility. It fulfills not only the special needs of *random motion testing*, but virtually any other test specification as well . . . such as sinusoidal motion testing, fatigue testing, automatic cycling, and provisions of MIL-E-5272A.

HEART OF THE SYSTEM—THE EXCITER

The MB Model C-25HB (shown) is rated at 5000 pounds peak force. Its table assembly is unusually stiff to reduce resonances yet weighs only 75 pounds. Axial resonance lies well over 2000 cps operating range.

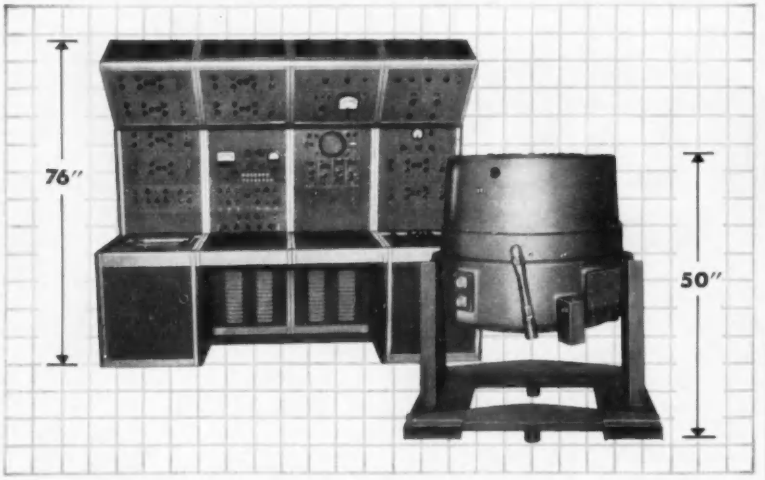
This and other MB Exciters for 200, 1200, 1700, 3500, 7000 and 15,000 pound force faithfully reproduce complex input signals when teamed with an MB amplifier and compensation console.

MATCHED PERFORMANCE

Other elements of the system are integrated with the exciter's high performance. An electronic *amplifier* fulfills the power demands. A control cabinet houses all necessary *instrumentation* plus frequency and amplitude *controls*. Circuits in a *compensation console* give automatic adjustment so that table acceleration remains proportional to input voltages. A top quality tape recorder for playback of the complex wave patterns may be used.

If you have any questions on vibration testing at all, come to a leading authority on the subject . . . the MB engineering staff.

MB *manufacturing company*
A DIVISION OF TEXTRON INC.
1060 State Street, New Haven 11, Conn.
HEADQUARTERS FOR PRODUCTS TO ISOLATE . . . EXCITE . . . AND MEASURE VIBRATION



Applications Received

Continued

Don Seaton, James W. Sugimura.

Indiana Section

Dale Eugene Bough, Dean K. Hanink, Ronald G. Stantone.

Kansas City Section

Robert M. Frost, Robert E. Weiler.

Metropolitan Section

Edward L. Apgar, Joseph Beyers, Jr., William T. Bonomo, Frederick A. Fielder, Samuel W. Handley, Sidney C. Howell, Paul George Jameson, Victor C. Leglise, Jr., John G. McDonough, Stanley L. Novak, Edward P. Percarpio, William J. Prechtl.

Mid-Continent Section

John H. Coverdale, Richard L. Holmes, James R. Liebhart, Richard R. Russell, Eugene T. Speller.

Mid-Michigan Section

Walter Vern Alley, Jr., Edward N. Harris, Hugo Lundberg, Jr., Keith T. Wolfenden.

Milwaukee Section

Kenneth A. Alexander, Clyde R. Bodenbach, James A. Donohue, Jr., Gerald Haft, Robert R. LeChevalier, William R. Massey, Mark J. O'Connell, S. E. Wolkenheim.

Mohawk-Hudson Section

Edward A. Dessureau, Kenneth Earl Parr.

Montreal Section

Rolland Asselin, Garfield K. Bowser, John F. Gellard, Albert Heeds, James A. Hutchins, Robert F. MacKie, Ian W. Shepherd, Ronald Whyte.

New England Section

Richard C. Fitzgerald, Mark Hallinan, Albert B. Liptak, Jr., Edward W. Reardon, R. W. Smith.

Northern California Section

Harrold R. Cochran, Henry F. J. Wilmot.

BENDIX PRODUCTS DIVISION

For a quarter of a century, Bendix Products Division has maintained leadership in many important automotive components. Today, Bendix* Power Brakes, Power Steering, wheel brakes, constant velocity joints and hydraulic remote controls are still the industry's choice for outstanding performance.

BENDIX-SKINNER DIVISION

With a new and modern plant Bendix-Skinner Division, originator of micronic filtration, has greatly increased its capacity to meet the design needs and production requirements of the automotive industry with over 350 types of filters.

MARSHALL-ECLIPSE DIVISION

One fact tells the whole story of the automotive products of the Marshall-Eclipse Division. Bendix-Eclipse brake linings and blocks are on more new vehicles than any other make of linings and blocks.

LAKESHORE DIVISION

This division manufactures hydraulic valves and cylinders for automotive and agricultural applications—specializing in power steering requirements. Also producer of grey iron castings, both in green sand and shell molding methods.

SCINTILLA DIVISION

As the world's foremost producer of ignition equipment, the Scintilla Division is particularly capable of supplying high-efficiency magnetos, battery ignition units, switches, electrical connectors, and fuel injection equipment.

ECLIPSE MACHINE DIVISION

Eclipse Machine Division will exhibit the revolutionary new Bendix "Electrojector"—the electronic fuel injection system. This division has manufactured over 115 million Bendix* Starter Drives and also the famous Stromberg* Carburetor and the Bendix* Electric Fuel Pump.

BENDIX RADIO DIVISION

The fact that Bendix* Radio not only is deeply engaged in production of all types of radio equipment, but is equally familiar with automotive problems as well, makes Bendix Radio the ideal choice of manufacturers interested in quality performance at production prices.

*REG. U. S. PAT. OFF.

Bendix
AVIATION CORPORATION

Applications Received

Continued

Northwest Section

Harold M. Olden.

Oregon Section

Wilbert C. Freer, James E. Hochandel.

Philadelphia Section

Albert Ambrosch, Elliott F. Daniels, John H. Geyer, Joseph H. Harrison, Stuart Alan Horn, Frank E. Mamrol, Jr., T. J. Nicholson, Charles H. Pancoast, Richard J. Shopf, William W. Thomas, II.

Pittsburgh Section

Stewart G. Fletcher.

St. Louis Section

George A. Feyerabend, John W. Schejbal, Jr., Louis J. Tricard.

Salt Lake Group

Daniel M. Schwartz.

San Diego Section

Alan Weir Abels, Robert J. Chillo, Philip W. Corbett, Richard E. Grabowsky, Ernest F. Kotnik, Robert E. Morris, Robert M. Overdeer, Jimmy Pisciotta, Donald M. Post.

South Texas Group

Leroy M. Huth, Ben Darlington White.

Southern California Section

Grant C. Adams, Richard Baverstock, Vernon Cunningham, Thomas C. Fenwick, M. C. Haddon, Elmer A. Lemire, Hugh MacInnes, Palmer Nicholls, Wilton E. Parker, William V. Reece, Harry J. Swartz, Otto C. Turchan.

Southern New England Section

W. Ernest Bancroft, Leland D. Cobb, Jr., Earl M. Curtis, John W. Kelly, Donald M. Lenef, George H. Raley, Lawrence J. Trudeau, Jr.

Syracuse Section

Richard N. Audas, Joseph A. Calleo.

Texas Section

Herbert G. Bradford, Francis R. Dunn, Edward L. Foster, Daniel W. Wildfong.

Twin City Section

James S. Holdhusen.

Washington Section

Edgar H. Fallin, Alfred E. Savage.

Wichita Section

Donald F. Hoadley.

Outside of Section Territory

Charles J. Brady, Thomas Clague, Robert D. Dixon, Robert E. Greenman, Roger J. Hageboeck, Edmond F. Hinds, Jr., Melvin E. Long, Cyril B. Rogers, William E. Rolls, Horst M. Schweighofer, Lee R. Scott, Jr., Robert M. Williams.

Foreign

Gerhard D. Drauz, Germany; Ton Joy, England; John R. Long, Jr., Venezuela; Walter T. Warner, Australia.

YA Radiators

IN Pacific Northwest logging operations or on jobs the country over where the going is rough and tough, you'll find Yates-American radiators holding up their end of the heavy work. The YA Radiator illustrated is a cast-tank, heavy duty type, built for both highway duty and the most punishing of off-highway operation. Whatever your products . . . if you require the best in radiators, write today for complete information. Yates-American Machine Company.

YA Yates-American
BELOIT, WISCONSIN
BRANCH OFFICES: CHICAGO, ILLINOIS; HIGH POINT, NORTH CAROLINA; MEMPHIS, TENNESSEE; PORTLAND, OREGON.

NEW THREAD CUTTING FASTENER

- LOW COST
- RE-USABLE
- SELF-LOCKING
- VIBRATION-PROOF
- SPRING TAKE-UP

Pulls up tight without backup on flat or contoured surfaces

Specially designed to hold die-cast or cold-forged name plates, emblems and trim against sheet metal surfaces, DOT's new T. C. F. cuts clean, deep threads on unthreaded studs, even those that are chrome plated. Immediately available to fit 1/8" and 3/16" studs.

When used with its pre-assembled plastic sealer, the new T. C. F. makes a watertight seal. The sealer *precedes* the fastener onto the stud so that it is not damaged by the thread-cutting process.

Available *in quantity* with or without sealer from Monadnock Mills subsidiary and Carr Fastener Division.

United-Carr's design staff is ready to apply the same engineering creativity that produced the T. C. F. and thousands of other special-purpose fastening devices to the solution of your special fastening problems. Field representatives are located in most principal cities.

T.C.F. for 1/8" stud shown actual size. Also available for 3/16" stud.

T.C.F. for 1/8" stud with plastic sealer.

MONADNOCK MILLS
SUBSIDIARY
San Leandro, California

DOT T.C.F.
THREAD CUTTING FASTENER

CARR FASTENER CO.
DIVISION
Cambridge, Massachusetts

UNITED-CARR FASTENER CORPORATION

these bottles are the key...

THEY WON'T BREAK

Plastic electrolyte containers have great resistance to impact.

THEY'RE LIGHTWEIGHT, COST LESS TO SHIP

15 plastic bottles weigh less than one glass bottle . . . save up to 30% on shipping charges.

THEY'RE SAFE AND EASY TO HANDLE

Handling sleeve in each carton lessens chance for spillage.

THEY'RE DISPOSABLE

Rinse out and destroy. No storing, re-filling or returning bottles . . . no cash tied up in carboys or empties.

to extra values you get with **GLOBE'S** dry-charged battery program

And here's why you can do a better merchandising job with today's finest dry-charged battery

DEVELOPED and backed by Globe-Union — a name that has meant top-flight batteries and battery merchandising for nearly forty years—this recently introduced program has but one aim. And that's to make *your* battery selling easier, more profitable . . a better buy for both you and your customers.

With dry-charged batteries, you eliminate trickle charge, standing loss . . . assure your customers of factory-fresh starting power. But when you "go with Globe," you get a host of additional values. You deal with a single, compact carton — a carton that contains battery, electrolyte and pouring sleeve. It's easier to stock and handle. And traffic-stopping design promotes striking, buy-compelling displays.

But the Globe extra value story doesn't end here.

FAST DELIVERY WHEREVER YOU'RE LOCATED

The 13 strategically located Globe dry-charge battery production plants, starred at right, assure quick and inexpensive delivery on dry-charged battery shipments.

COMPACT, EASY TO STORE AND HANDLE, ALL-IN-ONE CARTON contains battery, pre-measured, top quality electrolyte . . . safety-insuring pouring sleeve with printed instructions for activation.

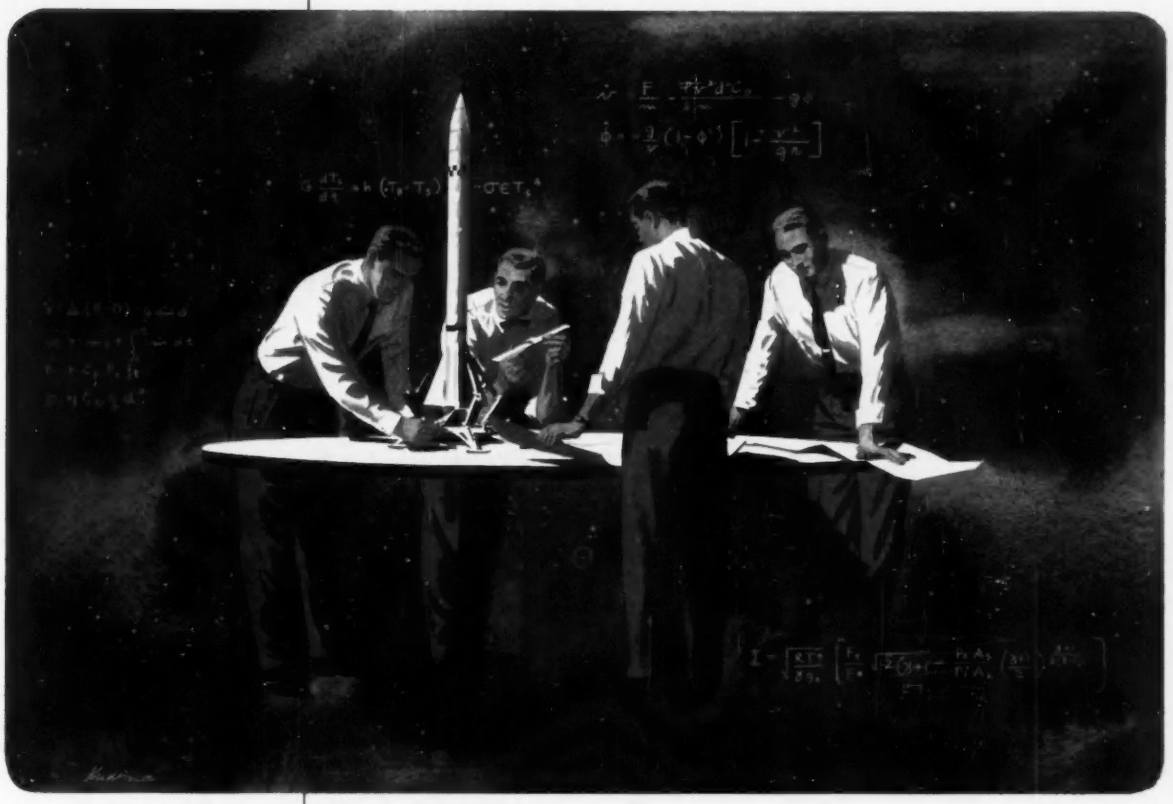
GLOBE-UNION INC.

MILWAUKEE 1, WISCONSIN

If it's petroleum-powered, there's a Globe-built battery — right from the start!

*ATLANTA, GA., *DALLAS, TEXAS, *EMPORIA, KANSAS, *HOUSTON, TEXAS, *LOUISVILLE, KY., *MEDFORD, MASS., *MEMPHIS, TENN., *MILWAUKEE, WIS., *MINERAL RIDGE, OHIO, *PHILADELPHIA, PA., *REIDSVILLE, N. CAROLINA, *SAN JOSE, CALIF., *HASTNGS-ON-HUDSON, N. Y., LOS ANGELES, CALIF., OREGON CITY, ORE., AJAX (ONTARIO) CANADA

IMPORTANT DEVELOPMENTS AT JPL



Integrated Teamwork in Missile Development

The Jet Propulsion Laboratory is a stable research and development center located north of Pasadena in the foothills of the San Gabriel mountains. Covering an 80 acre area and employing 1600 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U.S. Government.

Opportunities open to qualified engineers of U.S. citizenship. Inquiries now invited.

One of the most significant aspects of the Jet Propulsion Laboratory's progress has been its ability to develop an outstanding staff of engineers and scientists of top talent and ability. Prompt recognition of individual ability and initiative supported by authority to act has been, and is, an important factor in forming this progressive and productive research and development team.

These men, though individually responsible, work as a thoroughly integrated team on all aspects of the entire missile system instead of concentrating only on specialized missile components.

Since this includes development projects involving design, structure, propulsion, guidance, ground handling, etc., which are constantly influenced by continuing Laboratory research, the comprehensive program contains sufficient problem areas to challenge individuals of practically any phase of engineering interest.

The fluid character and constant progress of such activities at the Jet Propulsion Laboratory provide a stimulating attraction to qualified people interested in pioneering in basic research, applied research and also in actual development engineering.

JOB OPPORTUNITIES IN THESE FIELDS NOW

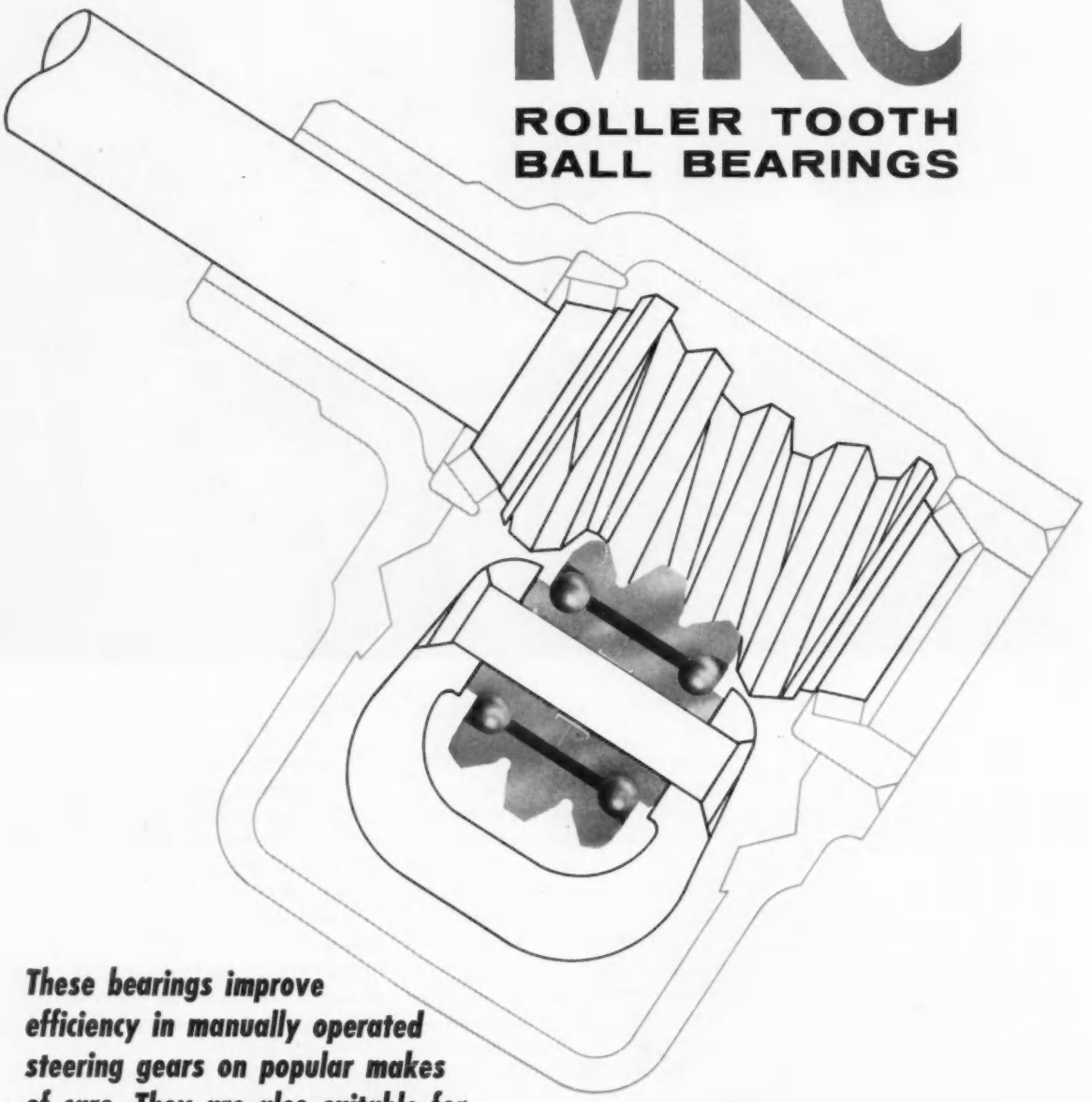
jpl

AERONAUTICS • MECHANICAL • STRUCTURES
DYNAMICS • PROPULSION
APPLIED MECHANICS • INERTIAL ELEMENTS

JET PROPULSION LABORATORY
A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA • CALIFORNIA

MRC

ROLLER TOOTH BALL BEARINGS



These bearings improve efficiency in manually operated steering gears on popular makes of cars. They are also suitable for truck and tractor applications.

Consult OUR Engineering Department on YOUR bearing problems

MARLIN-ROCKWELL CORPORATION

Executive Offices: **Jamestown, N.Y.**

MRC BALL AND ROLLER *bearings*

THINK OF IT...

THIS 5-axle tractor-trailer equipped with the *required* braking system and having a gross vehicle weight of 70,000 pounds

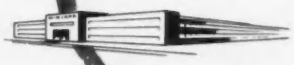
will require 115 feet more than normal service brake stopping distance if the trailer experiences a brake failure while the combination is traveling 50 miles per hour

. . .

However . . . if this same combination is equipped with *the Midland Dual Braking System*—the last word in tractor-trailer braking protection—*it will stop in at least 75 feet less distance* than if equipped with the required system.

Enjoy the *ultimate* in safety for your drivers and tractor-trailers for the public and property in general by standardizing on a Midland Dual Braking System for your tractor-trailers.

It will prove one of the most profitable investments you've ever made. . . . Any one of Midland's hundreds of distributors

will be happy to give you all the details . . . or you may contact the factory  direct.

P.S. To equip your tractor-trailers to meet present ICC braking requirements, see your nearest Midland Distributor. He's anxious to serve you.

THE MIDLAND STEEL PRODUCTS COMPANY

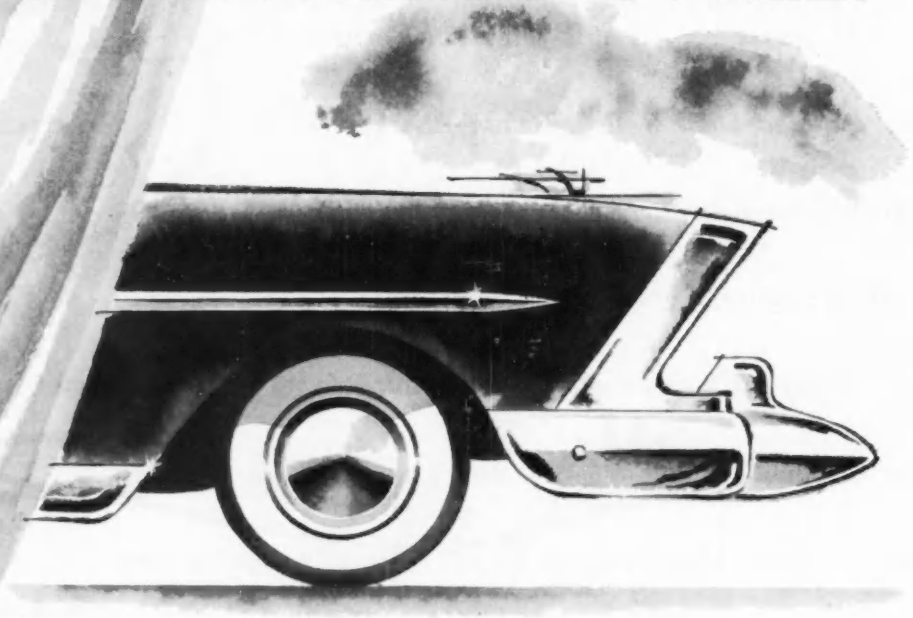
Owosso Division • Owosso, Michigan

Export Department: 38 Pearl Street, New York, N. Y.

MIDLAND
STEEL PRODUCTS CO.

IN 1957...

THE ACCENT IS ON STAINLESS STEEL!



This year's exciting new automobiles incorporate more stainless steel than ever. That's because stainless is the one metal that's never touched by wear . . . corrosion . . . and weather extremes.

Air, water, fumes, salt and road chemicals can't mar the durable beauty of stainless steel. It's solid and bright all the way through . . . resists dents and scratching . . . and returns to its original brilliant luster with just soap and water.

Stainless steel is functional as well as ornamental. Stainless trim has lasting built-in beauty. And functional components made of stainless have proved their rugged economy.

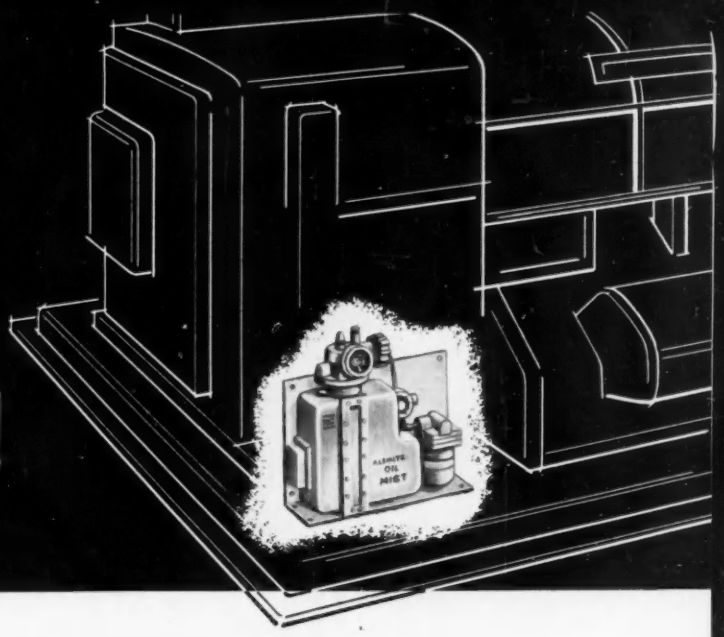
Ask your supplier for particulars. You can be sure that the Finest Stainless Steels are made with Vancoram Ferro Alloys.

Our 50 Years of Progress
1906 - 1956

VANADIUM CORPORATION OF AMERICA
420 Lexington Avenue, New York 17, N. Y.
Pittsburgh • Chicago • Detroit • Cleveland
Producers of alloys, metals and chemicals

VANCORAM

save up to 90% on lubricating costs!



ALEMITE OIL-MIST AUTOMATIC LUBRICATION

multiplies bearing life...cuts product spoilage ...boosts machine output in almost every industry!

Alemite Oil-Mist Automatic Lubrication brings remarkable savings . . . in lubricants, man-hours, bearing life, and decreased product spoilage.

Alemite Oil-Mist *atomizes* oil into mist—distributes it through tubing to bearings—bathes all bearing surfaces with a cool film of clean oil. Maintains uniform oil film on plain and anti-friction bearings, gears and chains—despite variations in load, temperature or speed. Amazingly simple, continuous and fully automatic . . . Alemite Oil-Mist eliminates the waste and uncertainties of the "human element" in lubrication.

Let us show you how Alemite Oil-Mist provides more efficient, foolproof lubrication, at lower cost! Mail coupon below for a graphic demonstration!

8 ADVANTAGES of the ALEMITE OIL-MIST System

1. Continuous Lubrication—Constantly deposits fresh, clean film of oil on all surfaces of all bearings in the system.

2. Fully Automatic Lubrication—Can start and stop with operation of machine switch.

3. Elimination of Guesswork—No bearing can be over-looked, nor over-lubricated! Every bearing picks up only as much Oil-Mist as it needs.

4. Reduction of Bearing Temperatures—Acts as bearing coolant, can lower bearing temperatures as much as 20° F.

5. Reduction of Types of Oil—Reduces number of oils that must be stocked, handled, and applied.

6. Elimination of Downtime—All bearings in the system are constantly lubricated while machines continue to operate.

7. Extension of Bearing Life—Multiplies bearing life many times. Life of grinding machine bearings has been extended from 400 to 7,000 hours!

8. As High As 90% Less Oil Consumption—Alemite Oil-Mist usually consumes about 1/10 the amount consumed by any other oiling method!

Alemite Oil-Mist Lubricates ALL Types of Mechanisms

Anti-friction Bearings | Plain Bearings | Chain | Gear | Gear Cases

A PRODUCT OF SW STEWART WARNER

ALEMITE

REG U S PAT OFF

A Product of STEWART-WARNER CORPORATION

Alemite Division of Stewart-Warner, Dept. JJ 126
1850 Diversey Parkway, Chicago 14, Illinois

☐ Please send me a FREE copy of your new and complete Oil-Mist catalog.

☐ Please have your Alemite Lubrication Representative arrange a no-obligation demonstration.

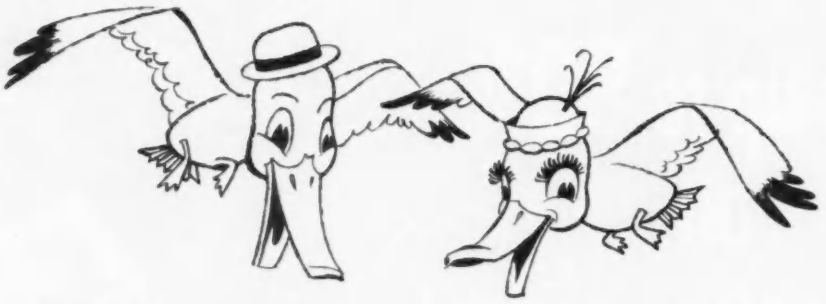
My Name.....

Title.....

Company.....

Street.....

City.....State.....



They are also birds of a feather ...all have SKF® bearings

By flocking to a single source where all basic types of bearings are available, many in the automotive industry are fast becoming "birds of a feather."

They share a common knowledge that **SKF**'s complete line provides a bearing with *plus values* for every application.

Why not profit by their experience, and wing your way towards **SKF**, today. 7732

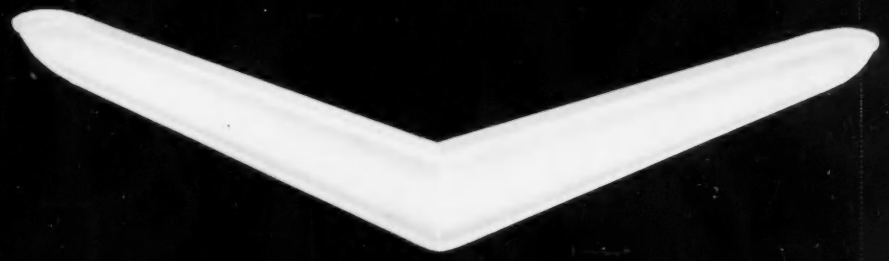
SKF

EVERY TYPE—EVERY USE

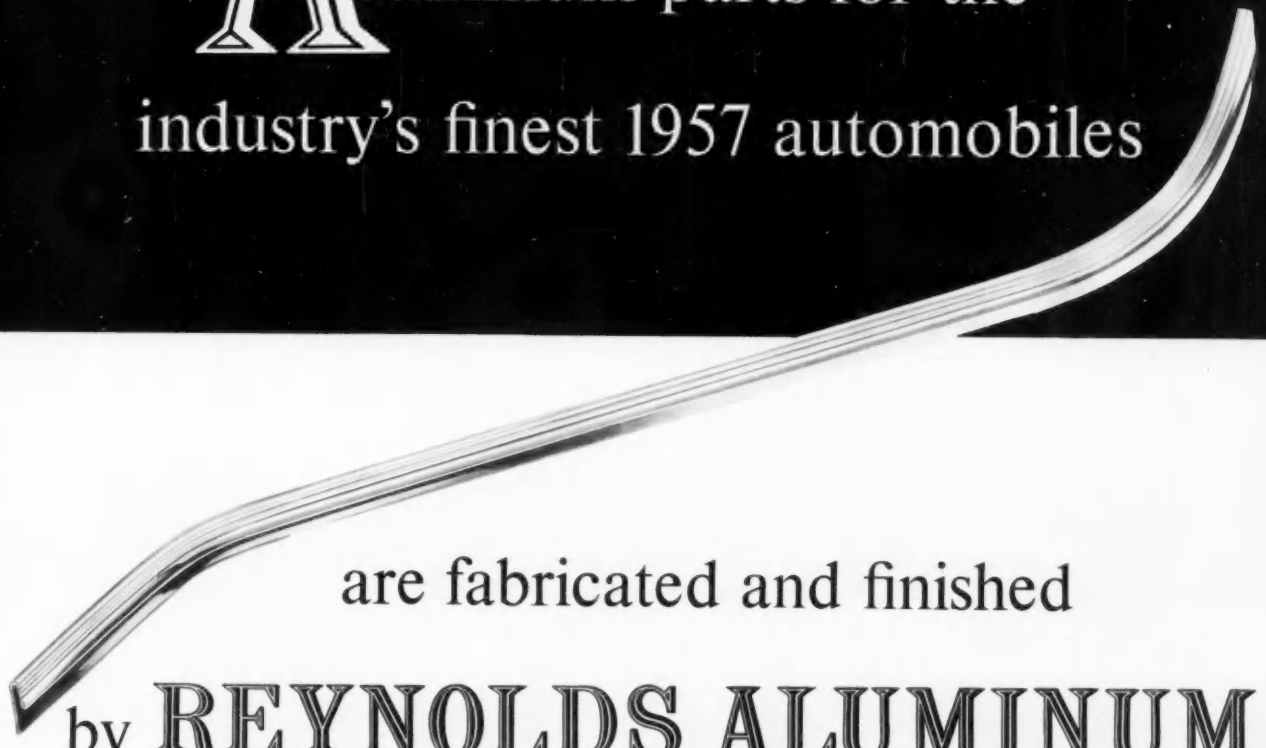
- *Ball Bearings*
- *Cylindrical Roller Bearings*
- *Spherical Roller Bearings*
- *Tapered Roller Bearings* ("Tyson")

*Reg. U.S. Pat. Off. Tyson Bearing Corporation

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.



Aluminum parts for the industry's finest 1957 automobiles



are fabricated and finished

by **REYNOLDS ALUMINUM**

FABRICATING SERVICE

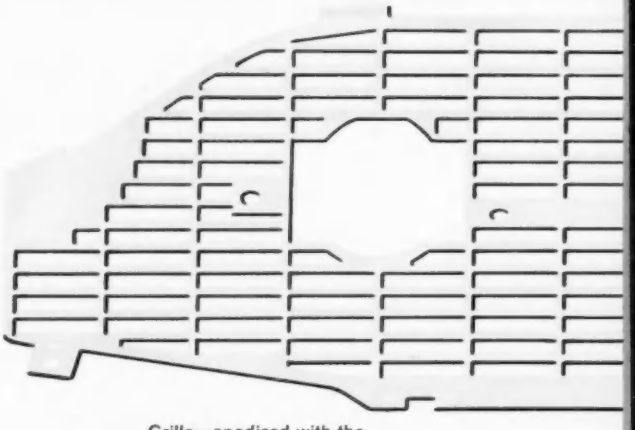
here's why...

There's added sales appeal, quality and economy in clear and color anodized aluminum parts and trim like these, fabricated and finished by

REYNOLDS ALUMINUM FABRICATING SERVICE

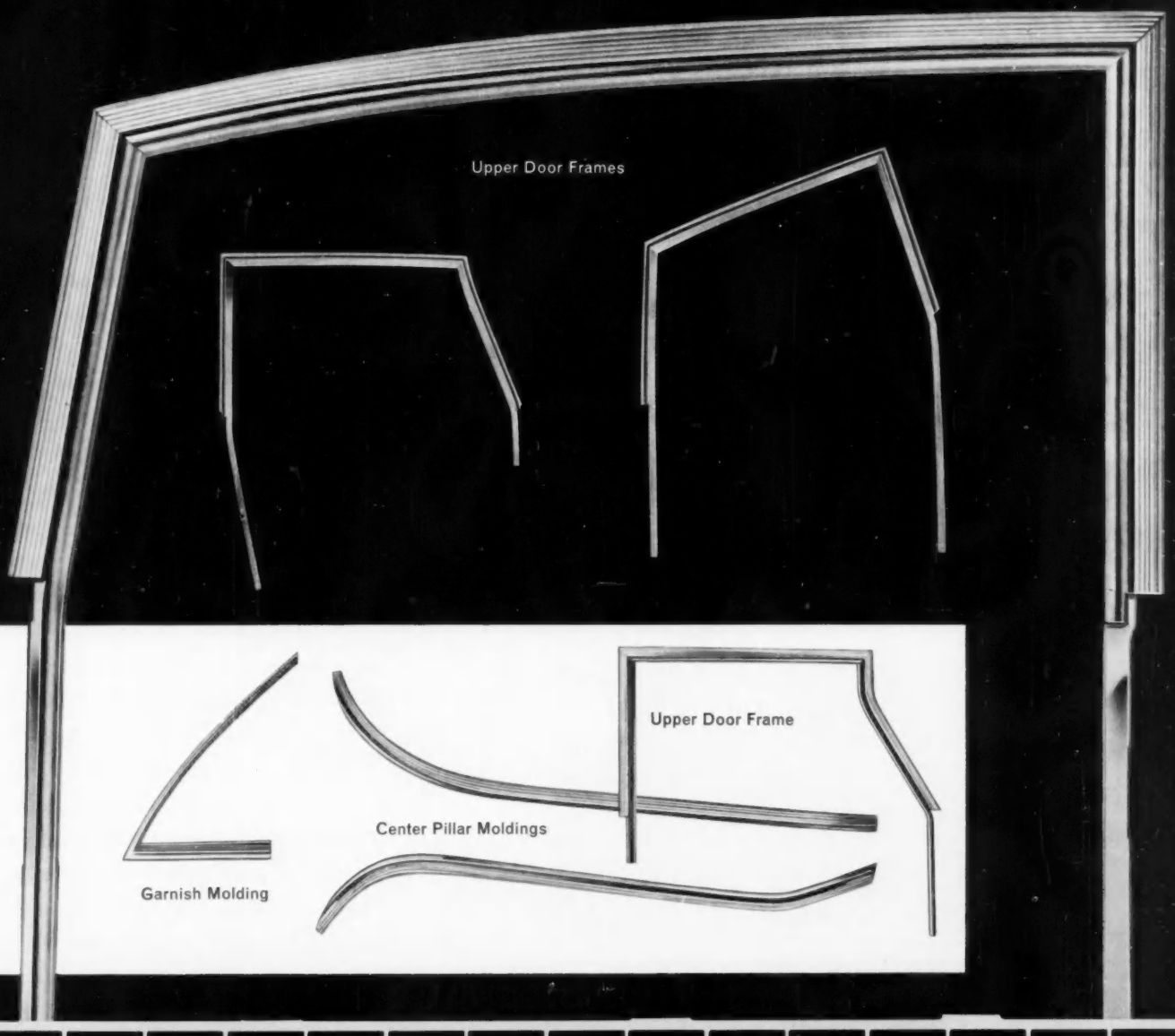
Side Panel Trim Strip
blanked and clear anodized by Reynolds
(additional fabricating done by another automotive supplier)

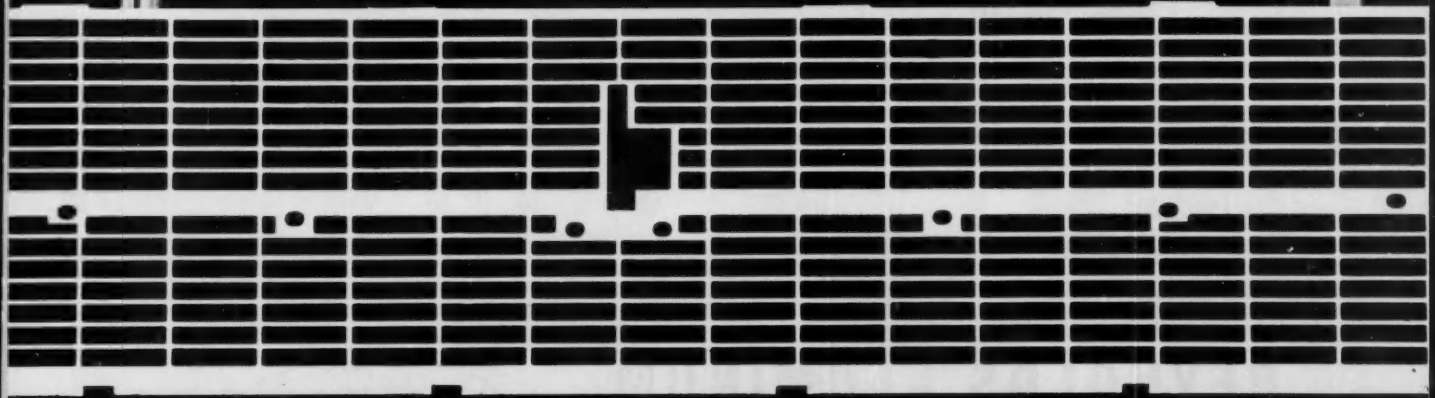
Headlamp Bezel



Grille—anodized with the
"gleam of gold" or the "look of sterling"

Hood Molding

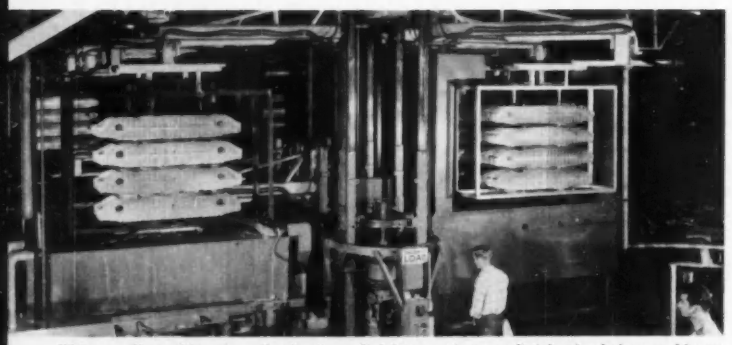




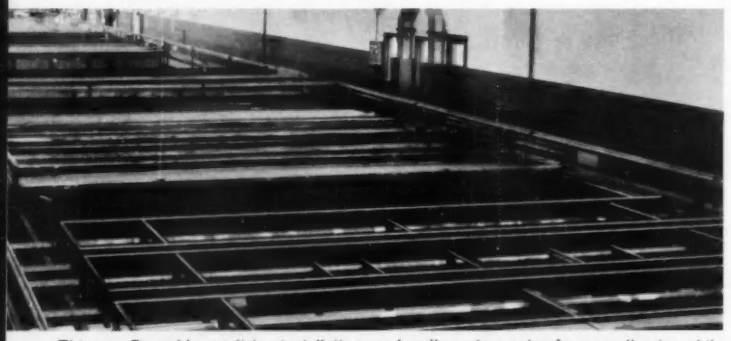
Here are some of the facilities Reynolds offers for production of aluminum automobile parts and trim...

At your service...

vast Reynolds fabricating and finishing facilities



This new Reynolds automatic aluminum finishing system can finish mixed sizes and types of automobile parts and chemically brighten or anodize them in different colors—and can handle several different jobs at the same time. An automatic coding system establishes the individual finishing specifications for each job.

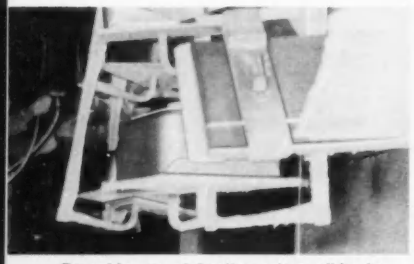


This new Reynolds anodizing installation can handle parts ranging from small automobile trim parts up to parts 24' long, 12' high and 4' wide. This half-block long system is another new addition to Reynolds multi-million dollar finishing facilities investment.

From start to "finish" on automobile parts and trim, Reynolds has more to offer. For example: Vast fabricating facilities with over 200 pieces of major production equipment in two plants alone plus finishing facilities unsurpassed anywhere. Quality control from mine to the finished part. Experienced design and engineering service.

These Reynolds strong points add up to greater sales appeal, quality and economy for automobile manufacturers. Sales appeal with gleaming *clear* or *color anodized* and mechanical, chemical and painted finishes. Quality stemming from quality control plus technological know-how in producing and fabricating aluminum. Economy because of the tremendous variety of most modern automatic fabricating and finishing equipment.

For full details on Reynolds fabricating and finishing facilities, contact your nearest Reynolds Branch Office or write *Reynolds Aluminum Fabricating Service, 2004 South Ninth Street, Louisville 1, Kentucky.*



Reynolds can paint entire parts a solid color, mask and paint or do paint filling in combination with mechanical finishing to supply most desired textures or highlighting effects.

Part of a battery of Reynolds new high speed buffing equipment used here on 1957 hood moldings.

Part of a battery of high speed coil fed presses at Reynolds producing at the high rate necessary to meet automotive industry requirements.

REYNOLDS ALUMINUM FABRICATING SERVICE

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING
ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

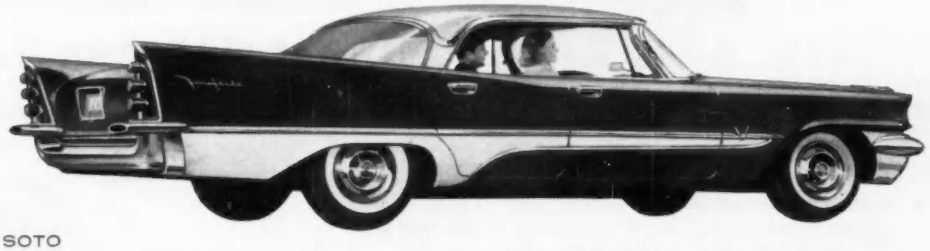
The Finest Products Made with Aluminum are made with REYNOLDS ALUMINUM

1957 PLYMOUTH

NEWEST NEW CARS IN 20 YEARS

1957 DODGE

WITH THE NEW SHAPE OF MOTION



1957 DE SOTO

WITH THE NEW TORSION-AIRE RIDE

1957 CHRYSLER

AND NEW PUSHBUTTON TORQUEFLITE

1957 IMPERIAL

CHRYSLER CORPORATION — THE *FORWARD* LOOK

COPYRIGHT 1956 BY CHRYSLER CORPORATION

"No car on the road handles like this Dodge!"

PROVING GROUND REPORT NO.

1

Torsion-Aire Ride

'Way outside Detroit, there's a guy who drives a new '57 Dodge —and all its competitors—around and around a brutal course. It's loaded with curves, hills, soft gravel, chuck-holes, and bumps.

This is test-driver Dick Schanz. And what does he say these days?

"I'm not kiddin'—no car on the road handles like this Dodge. When you turn a corner, you *know* you're going 'round that corner. And I mean 25-30 miles an hour faster than I can take them with other cars. Its lower center of gravity and new suspension snug it into the road. When I take her down a stretch, I just set back. These torsion bars keep it straight as a string.

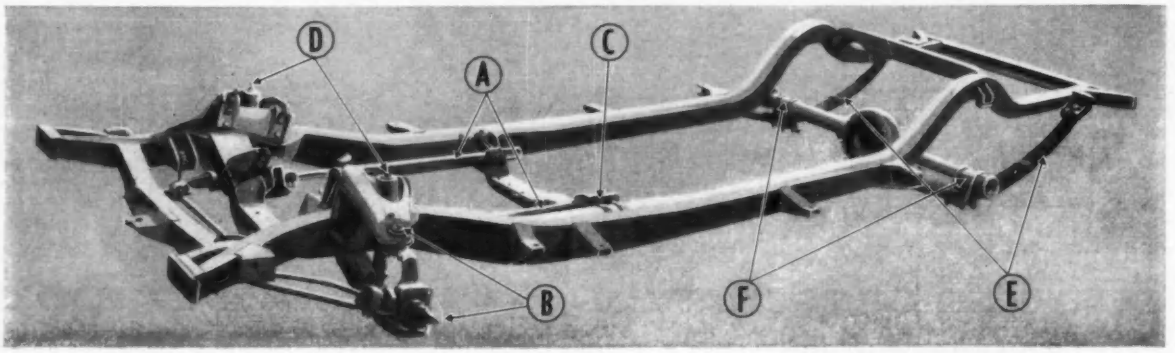
"And its ride relaxes you. It's like settin' home in a chair. It's really fun to go out and drive it!"

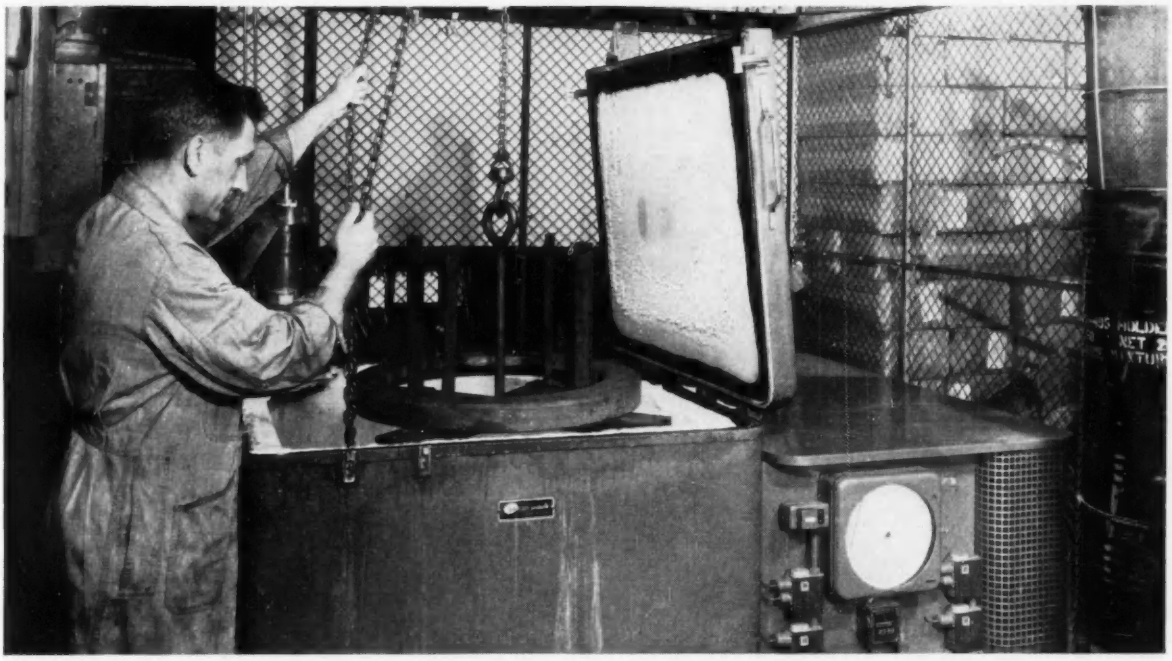
Dick's talking about dramatically new Torsion-Aire Ride. Why not drop over to your Dodge Dealer's and try this ride yourself?

Step into the wonderful world of Autodynamics

SWEPT·WING '57 Dodge

There's a lot to revolutionary Torsion-Aire Ride. (A) Torsion-bar springs up front, most efficient automotive springing ever devised. Driver Schanz has deliberately tried to crack Dodge torsion bars and has given up. (B) Completely new ball joints give better steering "feel." (C) Manual device to adjust car height. (D) New-valving shock absorbers flatten roads. (E) Outboard-mounted rear springs minimize body roll and "lean" on curves. (F) Rear axle mounted forward on rear springs to absorb torque. And there's much more, too: Anti-brake dip mountings. Larger tires with more rubber and air to soak up road noise and shock at its source. "Live rubber" wherever suspension system meets the frame.





AETNA FREEZES BEARINGS AT 130° BELOW ZERO

to give you better, more dependable anti-friction performance

Typical examples of Special Aetna Super-Precision Bearings . . . manufactured to the most advanced dimensional control standards including stabilization.

Looks warm and comfortable, doesn't he?—the operator pictured here. Actually he's only inches away from one of industry's coldest work spots—the "deep freeze" vault where Aetna bearing components are treated at temperatures as low as 130 degrees below zero.

This special sub-sub zero treatment makes certain that vital Aetna bearings built into high precision products will provide the dimensional stability so necessary for sustained peak efficiency and longest life expectancy. In this quick-aging process the steel's metallurgical structure undergoes transformation—from the relatively soft austenite retained from heat treating into the much harder, tougher, fatigue resisting property, martensite. The result is a stabilized bearing that permanently holds its precise tolerances and assures the lowest possible coefficient of friction no matter how severe or varied the operating temperatures may be.

We call this the "cold war" against friction—one of the many advanced ways and reasons Aetna consistently produces anti-friction products that lead the field in dependability and cost-cutting efficiency.

Perhaps stabilization can solve a stubborn bearing application problem for you, too. Aetna's technical staff is ready to help you investigate. Why not outline your problem for their study?

Aetna

40 YEARS

AETNA BALL AND ROLLER BEARING COMPANY

Division of Parkersburg-Aetna Corporation

4600 SCHUBERT AVENUE • CHICAGO 39, ILLINOIS

In Detroit: Sam T. Keller, 1212 Fisher Building, Detroit 2, Michigan—Telephone: TRinity 5-7800

Manufacturers of: Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Radial Ball Bearing Mounted Units • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Parts

Paul Richard (right) discussing compression-ratio trends with automotive engineers.

PAUL RICHARD . . . a new kind of industry representative

Paul Richard's job is an unusual one. He belongs to a new breed of "scientific ambassadors" who help coordinate the work and ideas of two major industries whose products work together at the consumer level—in this case, the petroleum and automotive industries.

By training and profession, Paul is an automotive fuel specialist. He is a member of the Du Pont Petroleum Chemicals Division's technical staff.

He joined Du Pont in 1949, and until 1953 did engine research work on fuels. His experience includes a great deal more than just passenger-car fuels. During World War II, he was with the National Advisory Committee for Aeronautics, where he worked on fuel evaluation, cooling, compound power plants, and turbo-jet fuel systems. Later, with the Lima-Hamilton Corporation, he worked on locomotive diesel engines and free-piston gas turbine power plants.

One of Paul's most important jobs today is keeping posted on the new engineering developments in the auto industry, especially those which affect the performance of fuels and lubricants. With this information, Paul and his associates at Du Pont are better able to forecast the chemical additive requirements of refiners, and can be of more help to them on their technical problems involving the use of additives.

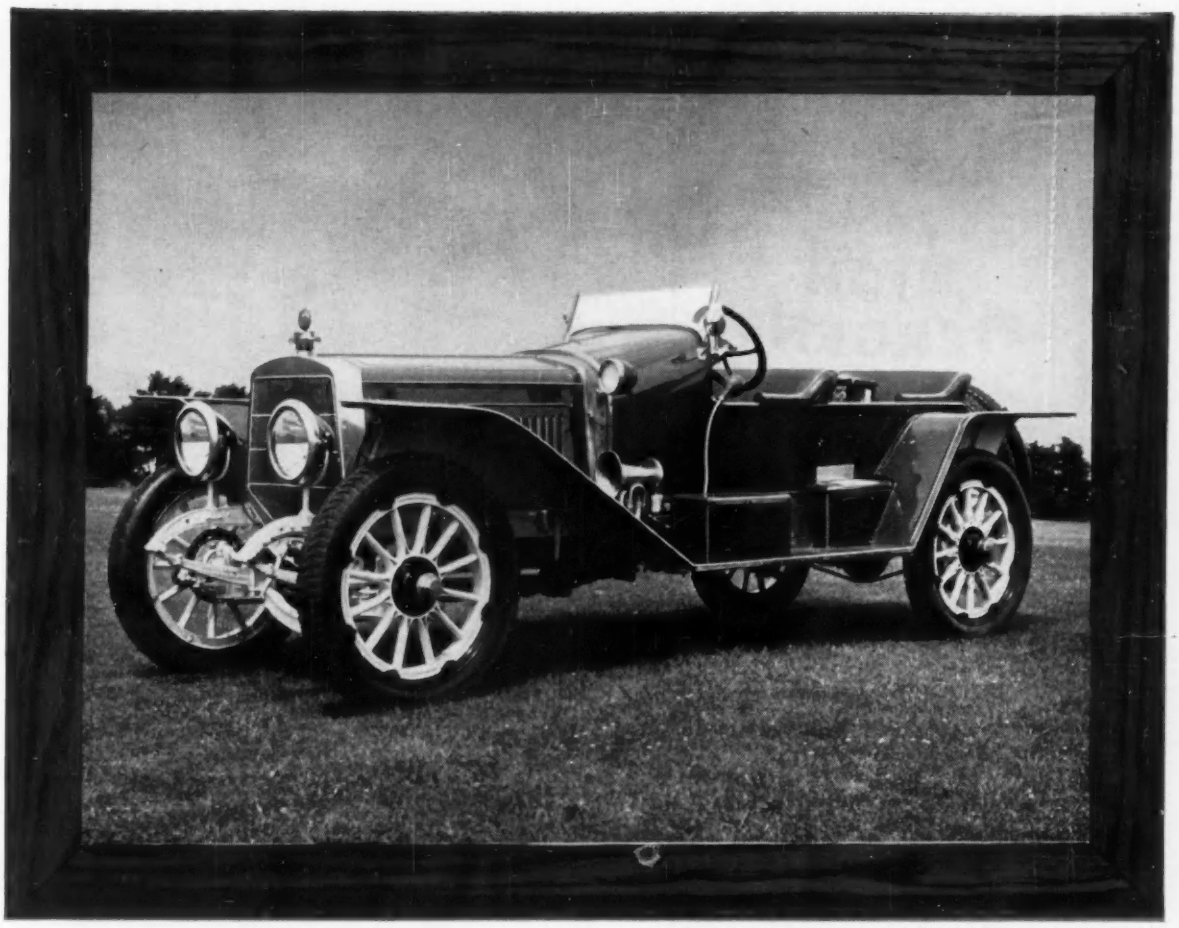
Swapping ideas on such subjects is of benefit to both the petroleum and automotive industries. In fact, this sort of free exchange of technical ideas has probably contributed materially to the progress of American industry as a whole.

If you have any problems where swapping ideas with any of our technically trained men might be of help, just let us know.

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & CO. (INC.) · Petroleum Chemicals Division · Wilmington 98, Delaware



Send for free print—1913 Lozier. This print, from collection of P. S. DeBeaumont, not for commercial use.

"Legitimately high-priced," the 1913 Lozier cost over $5000. It featured a modified toy tonneau body, a T-head six-cylinder engine with 51 h.p. and a top speed of 81 m.p.h. Ignition was dual battery and magneto. From 1907 to 1911, the Lozier maintained an enviable racing record. This is one of a series of antique automobile prints appearing in Morse advertisements. Write for your free copy, suitable for framing, to: Morse Chain Company, Ithaca, N.Y.

Over 75,000,000 Morse Timing Chains insure long service life of cars, trucks, and buses

On nineteen of the twenty-two current makes of cars, *Morse Timing Chain Drives* are specified as original equipment. Over the years, the auto industry has used more than 75,000,000 of these durable Morse Chains. Precision-built Morse Drives give car, bus, and truck owners long service life—plus freedom from maintenance worries.

If you have problems involving timing chain in design, development or application, check first with Morse. We have expert engineering service available to help you solve them quickly, profitably.

For further information, call, wire, or write: MORSE CHAIN COMPANY, ITHACA, NEW YORK.

MORSE BW* **POWER TRANSMISSION PRODUCTS**

*Trademark

Purolator's "SELECTIVE" FILTRATION leaves additives in

Beneficial additives stay in as HD and heat-resistant lube oils pass through the Micronic® element of a Purolator filter . . . even though the element is straining out sludge, water and impurities as small as one micron (.000039-inch).

It's one of the reasons why original equipment manufacturers in the automotive field use more Purolators than any other make of filter. Besides this "selective" filtration, the accordion-pleated Micronic element provides ten times the area of older types, making possible:

- ***High flow rates with minimum pressure drop.*** **Purolators themselves can be small . . . yet operate with pumps of standard size.**
- ***Maximum dirt storage capacity . . .*** **for long, efficient service life before replacement.**

Micronic elements do not channel. They are waterproof and warp-proof and remain unaffected by engine temperatures. There's a Purolator to fit every vehicle, tractor and other gasoline- or diesel-engine-powered unit in service today. Write for our automotive catalog, No. 2054, to Purolator Products, Inc., Rahway, N. J., Dept. A5-1217.

Filtration For Every Known Fluid

PUROLATOR

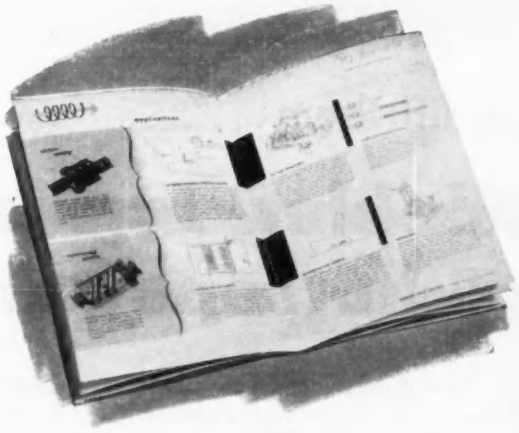
PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

FREE! YOUR NEW ACTUATOR and SPLINE "PROBLEM SOLVER"!

New 1957 Engineering Data Book from World's Largest Producers of Ball/Bearing Screws and Splines

36 pages crammed with time-, work-, and money-saving facts: Principles • Types • Basic Operations • Coupling Methods • Efficiency • Versatility • Advantages • Selection Factors • Design Data • Sample Problems, etc.



SAGINAW b/b SCREWS are *90%-98% efficient* (compared to 15%-20% efficiency of Acme screws). Require ⅔ LESS torque and power for same linear output—with consequent weight, space reductions. Function normally at −75° to +250° F. Two types: precision-ground or commercial rolled-thread. Have been built 1½ in. to 39½ ft. long.

SAGINAW b/b SPLINES have *40 times lower coefficient of friction* than sliding splines; transmit or restrain high torque loads far better; permit vital power, weight, space reductions. Have been designed 3 in. to 10 ft. long.

Saginaw ball bearing Screws & Splines

SAGINAW STEERING GEAR DIV., GENERAL MOTORS CORP., SAGINAW, MICH.

----SEND FOR YOUR FREE COPY TODAY-----

Saginaw Steering Gear Division, General Motors Corporation
b/b Screw and Spline Operation
Dept. 1E, Saginaw, Michigan

Please send 1957 engineering data book on Saginaw b/b Screws and Splines to:

NAME_____

COMPANY_____ TITLE_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

"So light, toy balloons can lift them . . ."

Bantam-weight Doehler-Jarvis Homelite pack 5 horsepower

The gasoline-engine-driven EZ is an eager little beaver . . . whips through an 18-inch pine in 14 seconds, an 8-inch oak in 5.

This just shows that magnesium die castings are the lightest of light.

And they are amazingly strong.

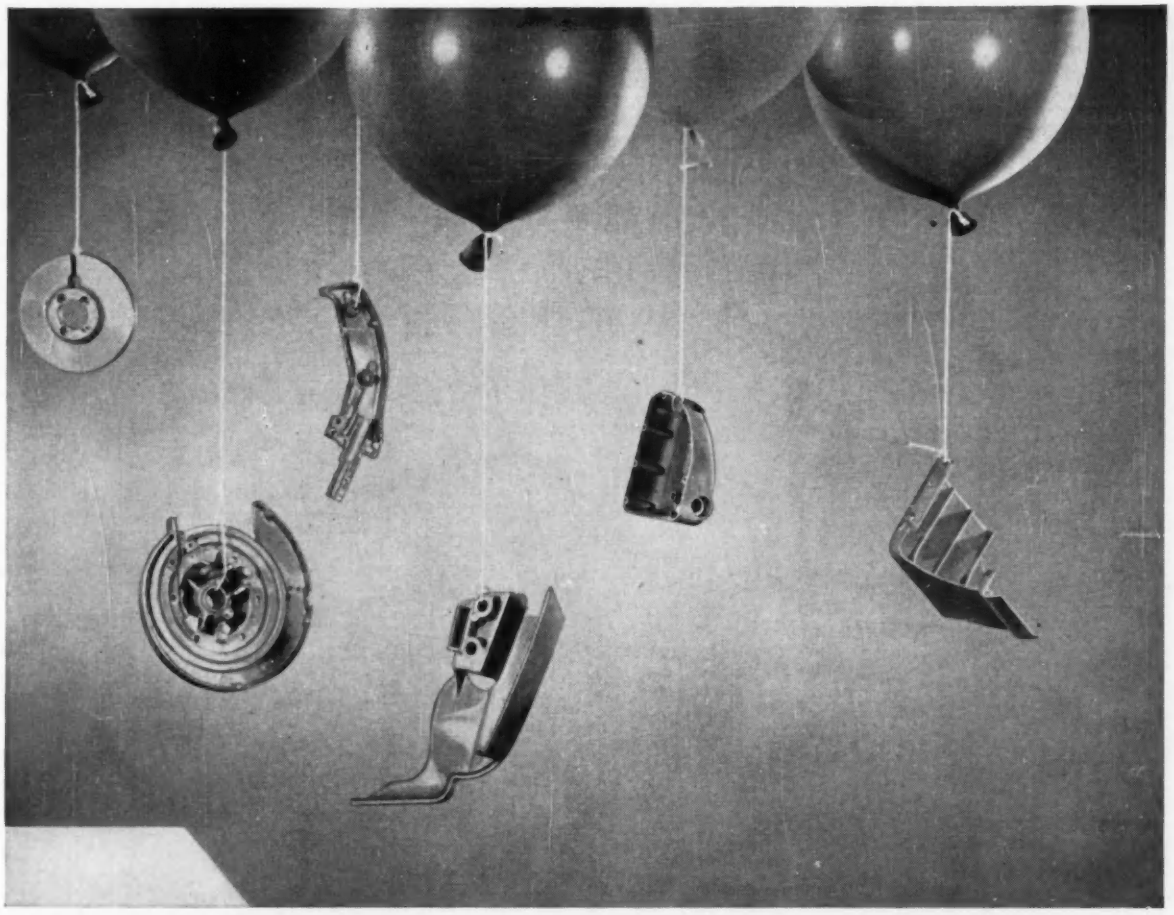
With these particular Doehler-Jarvis magnesium die-castings, for example, Homelite (division of Textron Inc.) packs 5 horsepower into their heavy-duty EZ direct drive chain saw and still keeps weight down to 19 pounds.

Design aids lightness, too

This sales-building lightness and strength is not based solely on the use of magnesium. Homelite and Doehler-Jarvis engineers also eliminate practically all excess metal. They do this by taking advantage of minimum thickness die-cast sections. Ribs provide rigidity.

They do away with much machining, too. And cast in several competitive advantages. For example:

- Die casting establishes accurate machining base points. These permit multi-jig production and both improve



magnesium die castings help into this 19-pound chain saw

dimensional accuracy and reduce cost.

- Servicing instructions in bas-relief are die-cast right into certain parts.

What's more, Doehler-Jarvis delivers the raw parts with near perfect "as cast" surfaces... surfaces that need only degreasing to accept a high-quality finish.

PA reports outstanding service

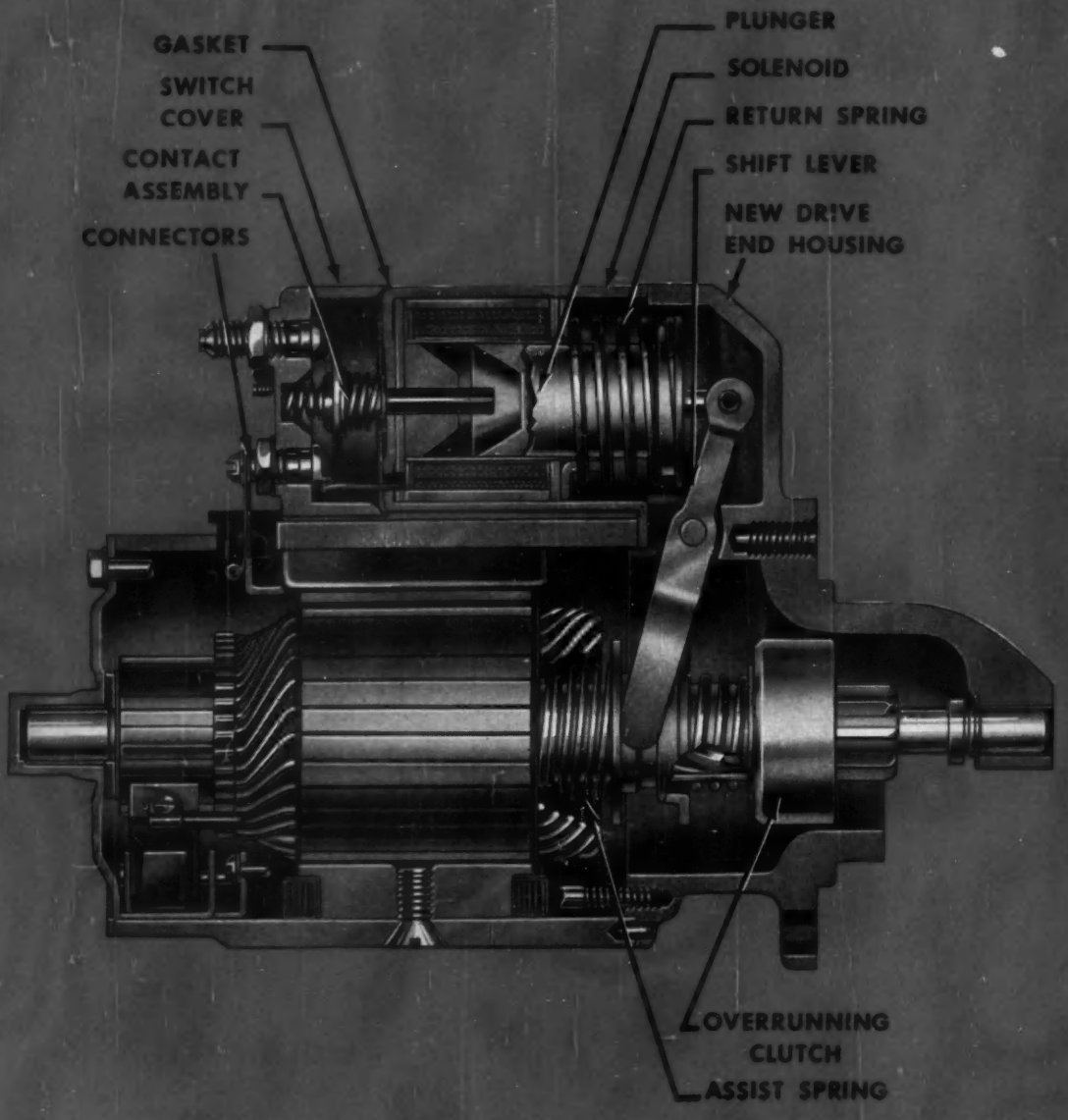
EZ sales got off the ground fast. Within weeks Homelite needed twice the projected quantity of castings. With a separate plant at Batavia, N. Y. for producing magnesium die castings, Doehler-Jarvis was able to respond quickly. Says Homelite's Purchasing Agent, "Those fellows out in Batavia have certainly done an outstanding job for us."

And you can be sure that Doehler-Jarvis *does* do outstanding work. Right now we're operating some 20,000 dies for some 1400 firms. Call us in on *your* next job.

Doehler-Jarvis
DIVISION OF NATIONAL LEAD COMPANY
General Offices: Toledo 1, Ohio

In Canada:
Barber Die Casting Co. Limited
Hamilton, Ontario

PROGRESSIVE ENGINEERING MAKES THE DIFFERENCE



NEW DELCO-REMY ENCLOSED SHIFT LEVER CRANKING MOTOR ON ALL GM CARS IN 1957

Delco-Remy's newly developed Enclosed Shift Lever cranking motor provides effective shielding from road splash, ice and dirt—assures greater starting dependability in all weather—requires no periodic lubrication.

The unique drive end housing completely encloses the entire shift mechanism, including solenoid plunger, lever, lever shaft, and overrunning clutch drive. Specially designed, the new built-in solenoid has a seamless drawn steel case, an improved gasket between case and switch cover, a longer bearing surface for the plunger, and an improved contact assembly with molded insulator actuating rod. The solenoid case is flange mounted tightly to the protective drive end housing, and the switch is electrically connected directly to the motor by extensions of the field coils which pass through an elastic grommet in the frame.

A special compressed assist spring on the armature shaft aids the solenoid during initial movement to provide more positive shift action on engagement. A strong, smooth-acting, compression-type shift lever return spring—located inside the solenoid case—assures quick, unhesitating disengagement from the flywheel.

The new, more compact, smaller diameter overrunning clutch saves vital mounting space—reduces interference problems—makes possible a shorter overall motor length.

This revolutionary new cranking motor—original equipment on all General Motors cars for '57—is another example of Delco-Remy leadership "Wherever Wheels Turn or Propellers Spin."

DELCO-REMY • DIVISION OF GENERAL MOTORS • ANDERSON, INDIANA

GM GENERAL MOTORS

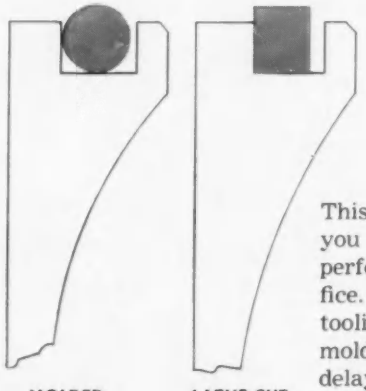
GENERAL MOTORS LEADS THE WAY—STARTING WITH

Delco-Remy

ELECTRICAL SYSTEMS

Why ACADIA LATHE-CUT SYNTHETIC RUBBER SEALS

can save you money in *STATIC* or *MOVING* seal applications



MOLDED O-RING SEAL

LATHE-CUT SEAL

This seal will save you money with no performance sacrifice. Minimum tooling cost, no molds, no costly delays. Can be made up to 25" I.D.

Acadia Synthetic Rubber Parts are of the highest quality components, processed for oil resistance, good aging properties, resistance to heat. They can be furnished in any dimension or special compound you desire to precision tolerances. They are another example of Acadia's ability to SAVE YOU MORE..SERVE YOU BETTER.

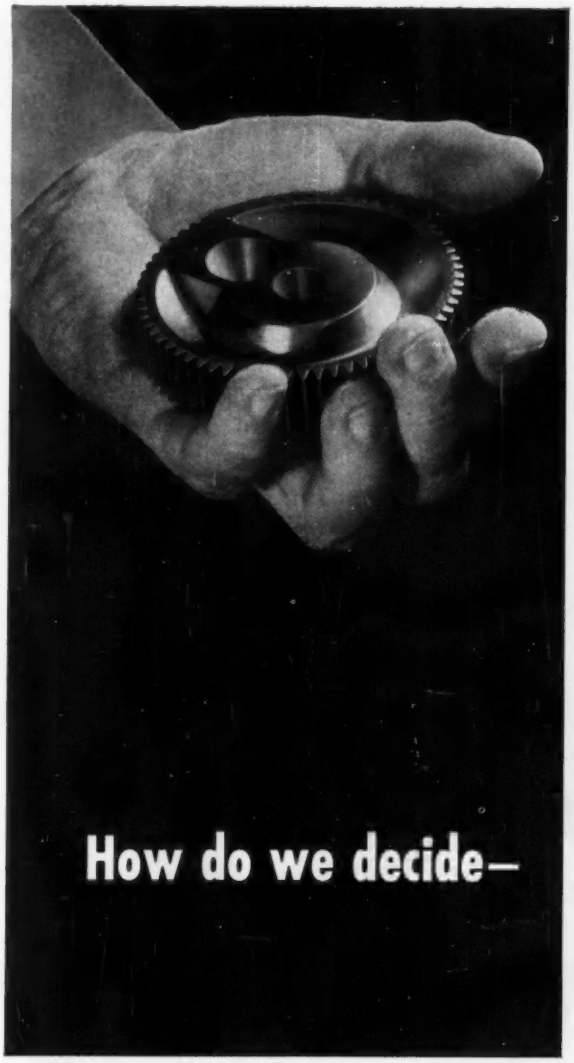
There's an Acadia Sales engineer near you to serve you. Write us today, and we'll put him in touch with you immediately.

ACADIA *Synthetic* **PRODUCTS**

DIVISION OF WESTERN FELT WORKS
4021-4139 West Ogden Avenue, Chicago 23, Illinois

Branch Offices — LOOK in the 'Yellow Pages' — in Principal Cities

MANUFACTURERS AND CUTTERS OF WOOL FELT



which part should be made of metal powder?

We ask: **How will it be used in the end product of which it will be a component?** What are the loads, tolerances, and shape of the individual part? How will it be lubricated? Are there any special requirements such as hardness and finish? Do the quantities justify tooling costs?

These are the questions that were answered before any decisions were made on the parts shown above —both of which are made of metal powder.

Because Moraine Products can draw upon a wide range of experience with many different mass production processes and their applications to specific problems, our judgment on these questions can be considered sound. When we recommend metal powder, it is because we are convinced, in our own minds, that it is the material and the process best suited for the job the specific part must do.

Moraine Products also produces: Moraine Power Brakes—Delco hydraulic brake fluids, brake assemblies, master cylinders, wheel cylinders, and parts—Moraine friction materials—Moraine-400 and M-100 automotive engine bearings—self-lubricating bearings and porous metal filters—rolled bronze and bi-metal bushings.

Another General Motors Value

Moraine Products
Division of General Motors, Dayton, Ohio

TUNG-SOL®

VISION-AID HEADLAMPS

5040-S for 6 volt passenger cars
5400-S for 12 volt passenger cars
5440-S for 12 volt trucks and buses

WITH E·Z AIM PLATFORMS

FOR USE WITH ANY APPROVED AIMING DEVICE

The new improved Tung-Sol Vision-Aid Headlamp can be quickly adjusted with any approved aiming device—or can be aimed visually. Three E-Z Aim Platforms, precision-molded on the face of the lens, provide contact points for all the new mechanical aimers. They assure accurate beam adjustment in a matter of minutes—even in broad daylight. These headlamps are fully interchangeable with all sealed beam headlamps of the same voltage.

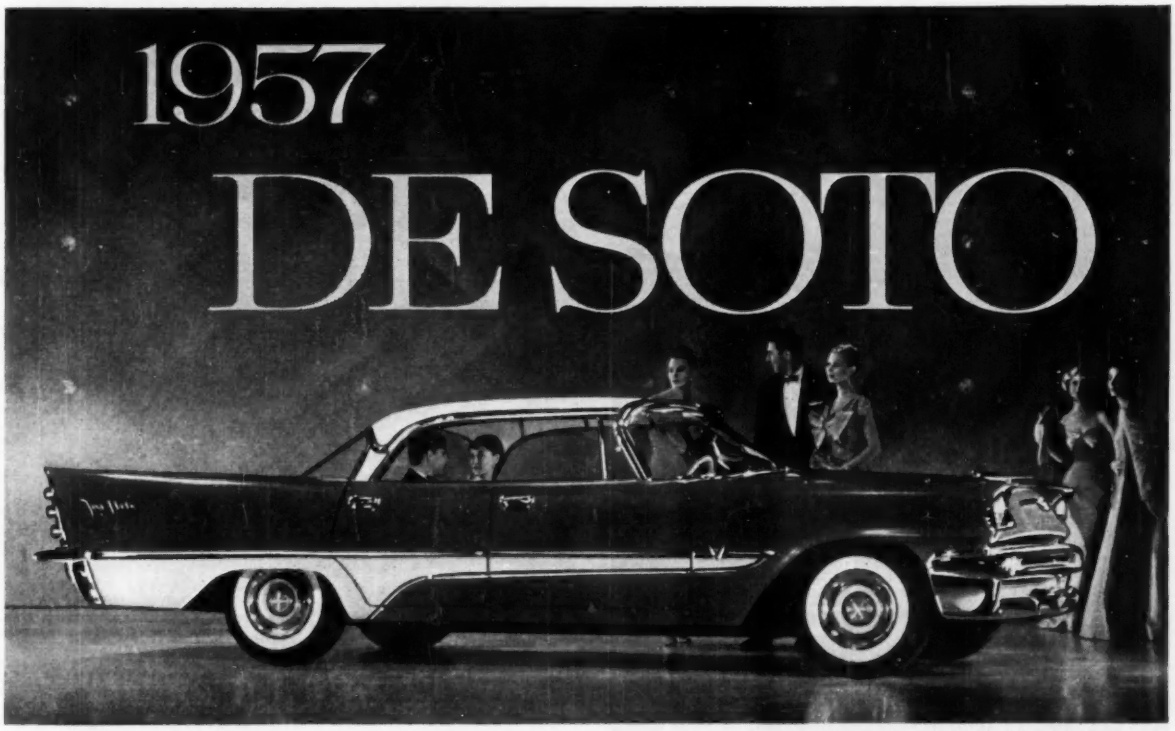
Car owners benefit from wonderful new safety features of all Vision-Aid Headlamps: The new, more powerful beam gives 80 extra feet of seeing distance down the right side of the road; the filament cap and new lens design improve visibility in rain, fog and snow.

They insure complete satisfaction for car manufacturers, because traditional Tung-Sol quality and nationwide distribution more than meet performance and service requirements.

TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.

Sales Offices: Atlanta, Ga., Cincinnati, Ohio, Culver City, Calif., Dallas, Texas, Denver, Colo., Detroit, Mich., Irvington, N. J., Melrose Park, Ill., Newark, N. J., Philadelphia, Pa., Seattle, Wash., Canada: Montreal, P.Q.

80 EXTRA FEET OF SAFETY... ACCURATELY AIMED!



FIREFLITE SPORTSMAN BY DE SOTO. GOWNS BY I. MAGNIN

These great advances make the '57 DE SOTO the most exciting car in the world today!

New *Flight Sweep* styling. For 1957 De Soto presents the new shape of motion! Long, upswept tail fins; sleek, lower-than-ever lines; 40% more glass area.

New *Torque-Flite* transmission. Most advanced transmission ever built! Tremendous getaway and passing power . . . velvet-smooth acceleration.

New *Torsion-Aire* ride. Here is the smoothest ride you've ever had in an automobile. You take corners without lean or sway. Braking is level as a table top.

New super-powered V-8 engines. There are three powerful new De Soto V-8's to choose from . . . with higher-than-ever horsepower for safer passing.

New *Push-Button* control. Simply touch a button of De Soto's new Triple-Range push-button control—and you're on your way!

De Soto dealers present

Groucho Marx in "You Bet Your Life" on NBC radio and TV

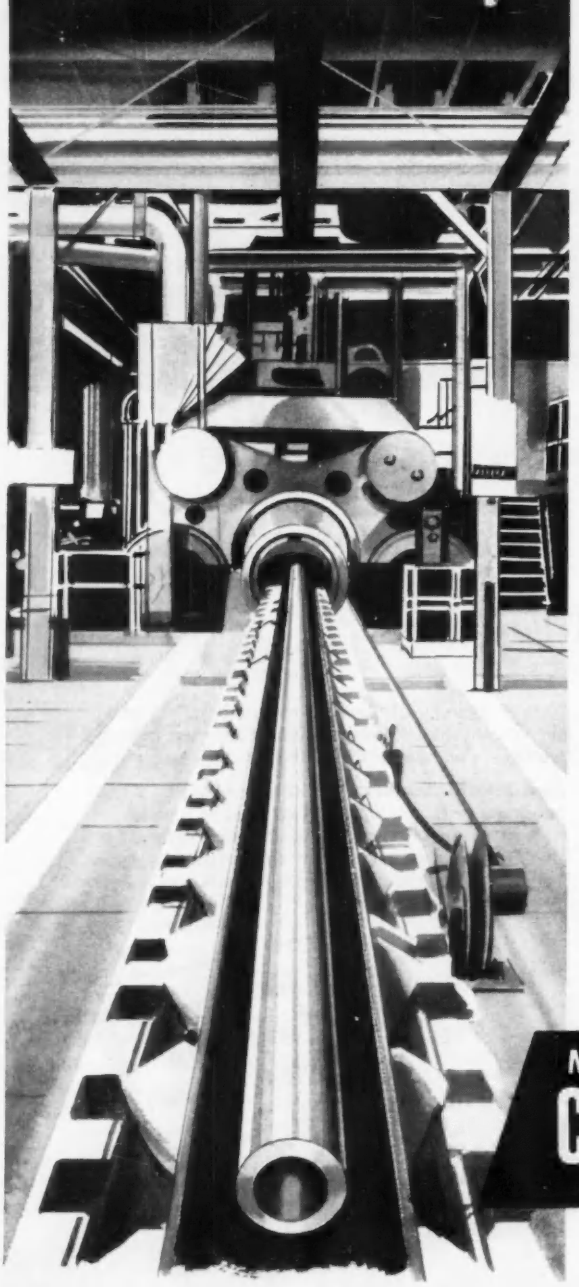
New *4-Season* air conditioner. Mounted out of the way under the dash—it *cools* in summer, *heats* in winter . . . one simple set of controls.

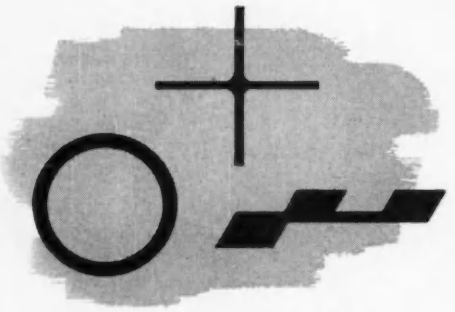
New interior features. Exciting new fabrics, smart accenting trim, new flight-styled instrument panel.

Your choice of every advanced power feature. See the most exciting car in the world today at your neighborhood De Soto-Plymouth dealer's.

Be sure to see the new
De Soto FireSweep
Priced just above the lowest!
The Most Exciting
Value in the World Today
See it! Drive it! Price it!

Shaping a new future for Industry





CURTISS-WRIGHT extrudes steels in shapes, lengths and sizes never before possible

Curtiss-Wright's Metals Processing Division is pushing steels into new uses for all industries. Shapes and sizes never before possible are being extruded in constantly increasing tonnages from alloy steels, stainless, titanium and other metals.

Starting with billets weighing up to 9000 pounds, the world's largest horizontal steel extrusion press moves the metal into shapes of virtually any profile that can be circumscribed by a 20-inch circle. Or, in a matter of seconds, the raw material may become heavy wall tubing up to 22 inches in diameter.

The 12,000 ton extrusion press and the complete facilities of Curtiss-Wright's Metals Processing Division are ready to go to work for you . . . to advance the design and production of metal products beyond the limitations of conventional equipment. Qualified engineering consultation available at all branch offices.

77 Grider Street

METALS PROCESSING DIVISION
CURTISS-WRIGHT
CORPORATION • BUFFALO, N. Y.

Metals Processing Division Branch Offices:
New York • Houston • Los Angeles

ELECTRONICS • NUCLEONICS • PLASTICS • METALLURGY • ULTRASONICS • AVIATION

Naugatuck PARACRIL

The oil-resistant nitrile rubber

"...the rubber we know will resist 'em all!"

"We can't be sure just what kind of oil or other hydraulic fluid will be in contact with our hydraulic hose liners, pressure seals and accumulator bladders, so we use the rubber we know will resist 'em all!" That was the reply when one manufacturer of rubber products was asked about his choice of PARACRIL® for rubber hydraulic specialties.

"In addition, PARACRIL gives us the low-temperature flexibility and other properties needed to meet government specs. The broad range of PARACRIL types enables us to achieve, at low cost, almost any combination of oil resistance and required physicals. We also use PARACRIL for lining our gasoline, fuel oil and liquid petroleum gas hose because of its superior resistance to aromatic hydrocarbons."

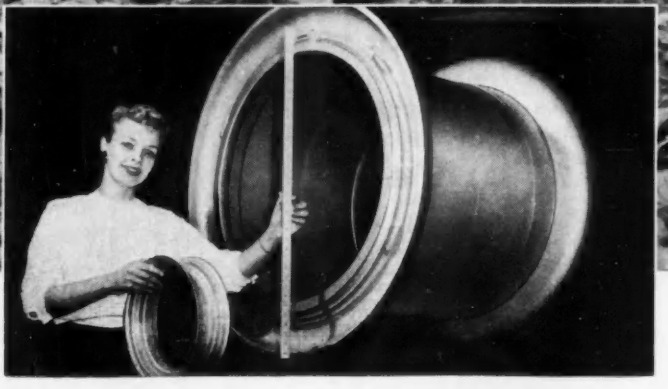
Whenever softening or swelling of rubber in contact with oil may decrease efficiency or shorten service life, designers and users alike will do well to specify PARACRIL. Extensive literature on PARACRIL nitrile rubber is now available. Write us the exact nature of your interest in oil- and grease-resistant rubber and we'll gladly send you, without cost, the pertinent technical bulletins.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

IN CANADA: NAUGATUCK CHEMICALS DIVISION • Dominion Rubber Company, Limited, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

Here's the rim that on the world's



During construction of the new Indiana Toll Road, giant vehicles like this one roll on Goodyear Tubeless Tires mounted on Tru-Seal Rims.

puts tubeless tires toughest jobs

Whether your equipment is the smallest truck or the largest earth-mover, you'll find a Goodyear Rim that's made for the job.

—thanks to Goodyear's exclusive Tru-Seal principle

Nowadays, there's no operation too severe, no terrain too tough for the wonderful new tubeless tires.

A big reason for their success is Goodyear's development of the Tru-Seal Rim.

This noteworthy rim advance introduced the now celebrated Tru-Seal principle—the only sound and certain method yet devised to seal a multiple-piece rim. It insures simple airtight mounting for tubeless tires —on all vehicles using 12:00 or larger tires.

Tru-Seal is the latest in a long series of rim improvements pioneered by Goodyear. With all Goodyear Rims, you profit by such advantages as:

Unusual Strength—Thanks to an exclusive double-welding process, and added support at points of greatest stress, present-day Goodyear Rims are far stronger than previous rims.

Ease of Tire Mounting—No tube and flap troubles.

Special Tools—Goodyear alone provides both hydraulic and hand tools especially made for off-the-road equipment.

Bond-a-Coat Finish—This protective coating affords long-lasting resistance to rust and corrosion.

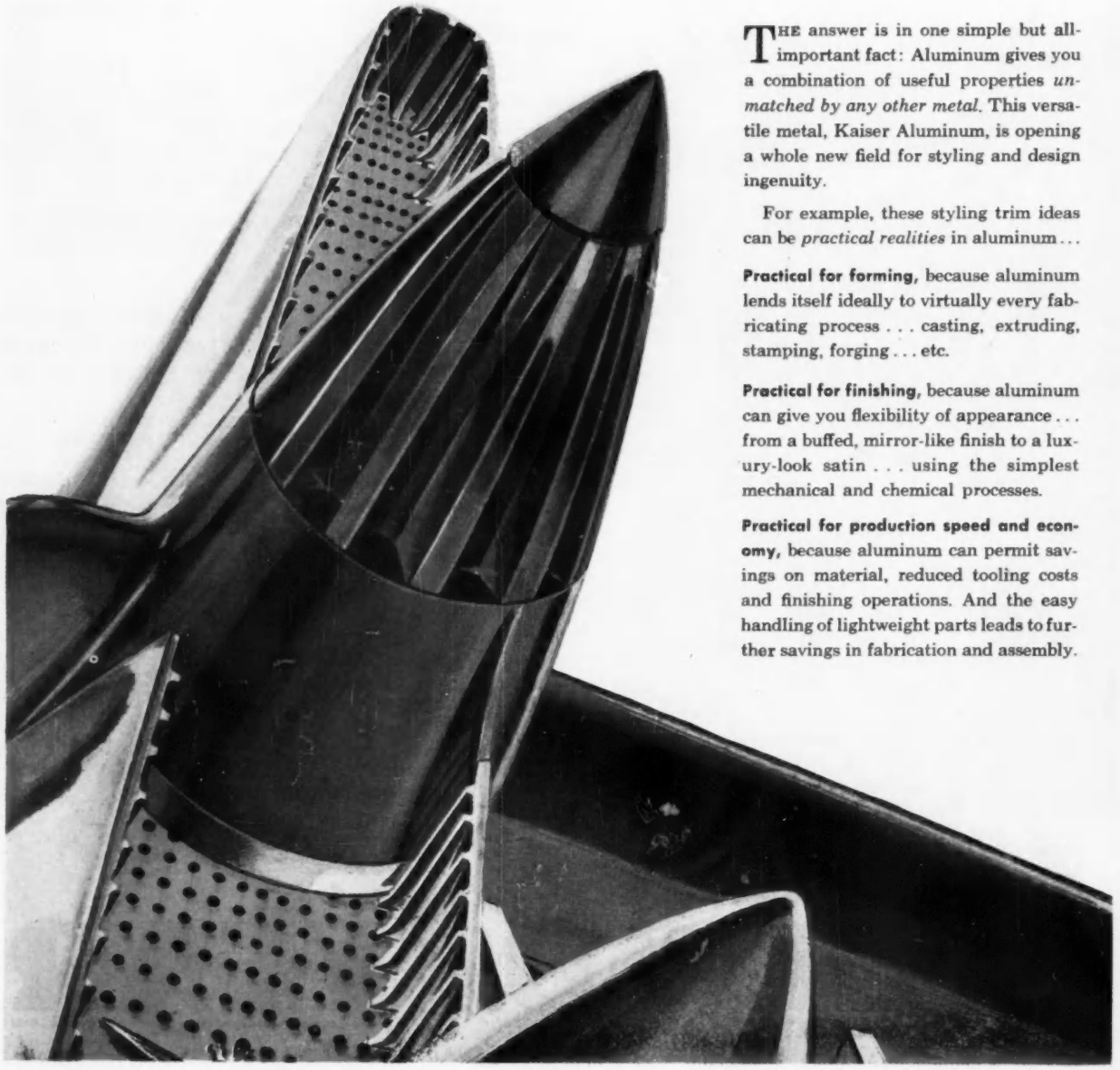
Next time you have a rim problem, why not discuss it with the G.R.E. (Goodyear Rim Engineer)? He'll save you time and money by helping you select the type and size of rim best suited to your needs. Write him at Goodyear, Metal Products Division, Akron 16, Ohio, or contact your local Goodyear Rim Distributor.

Buy and Specify **GOODYEAR**

Tru-Seal—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio

MORE TONS ARE CARRIED ON GOODYEAR RIMS THAN ON ANY OTHER KIND

How can aluminum help you style and sell



THE answer is in one simple but all-important fact: Aluminum gives you a combination of useful properties *unmatched by any other metal.* This versatile metal, Kaiser Aluminum, is opening a whole new field for styling and design ingenuity.

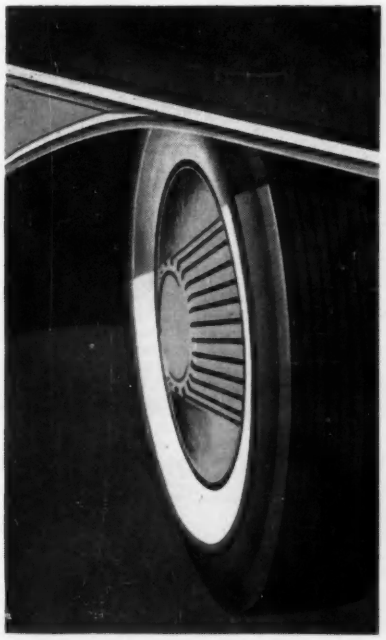
For example, these styling trim ideas can be *practical realities* in aluminum...

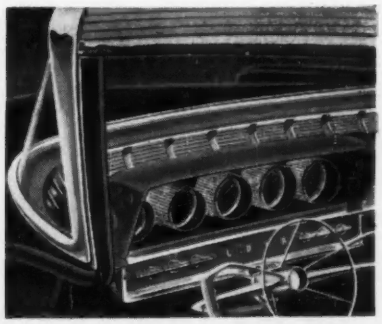
Practical for forming, because aluminum lends itself ideally to virtually every fabricating process . . . casting, extruding, stamping, forging . . . etc.

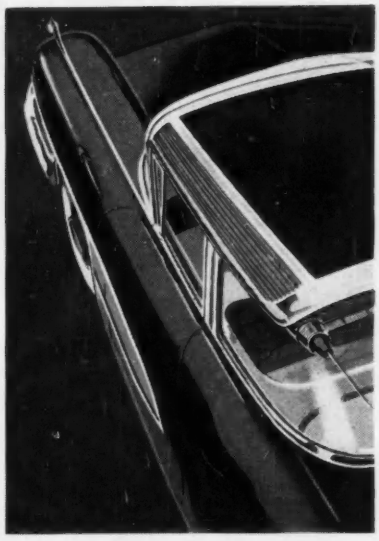
Practical for finishing, because aluminum can give you flexibility of appearance . . . from a buffed, mirror-like finish to a luxury-look satin . . . using the simplest mechanical and chemical processes.

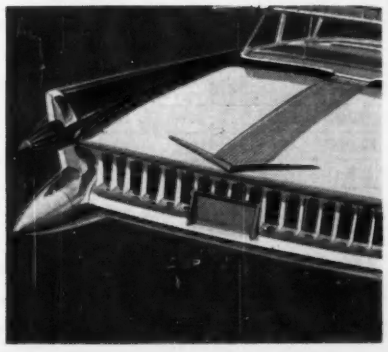
Practical for production speed and economy, because aluminum can permit savings on material, reduced tooling costs and finishing operations. And the easy handling of lightweight parts leads to further savings in fabrication and assembly.

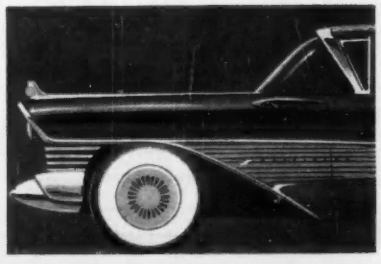
tomorrow's car?











And — again through this unique combination of *properties* — aluminum provides extra benefits that can be used as sales advantages . . .

Lasting beauty, solid aluminum, with no plating to chip, wear or peel.

Rust-proof, corrosion resistant.

Easy to maintain, "new look" for the life of the car helps boost trade-in value and lowers reconditioning costs.

Our Automotive Development engineers are available to work with you as "idea partners". . . introducing new developments such as Kaiser Aluminum's exclusive, *sunfast* gold-color aluminum alloy . . . as well as to help you on any specific requirements and problems in aluminum alloy selection and fabrication.

For further information, call our Automotive Industry Division, TRinity 3-8000, Detroit. Kaiser Aluminum & Chemical Sales, Inc., 2214 Fisher Bldg., Detroit 2, Michigan.

See "THE KAISER ALUMINUM HOUR." Alternate Tuesdays, NBC Network. Consult your local TV listing.

Kaiser Aluminum

Missile Designers:

JACK & HEINTZ OFFERS YOU 3 TYPES OF

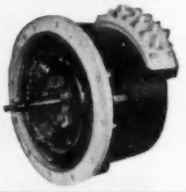
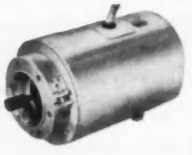
Environment-Free Generators

J&H machines deliver full-rated output independent of speeds, ambients, altitudes

In answer to the electric power needs of such weapons as North American's *Navaho* and Boeing's *Bomarc*, Jack & Heintz has successfully developed three approaches to the design of environment-free generators for missiles. With many completed units within each classification, J&H is in a position to meet quickly the requirements of missiles of all types: SSM SAM ASM AAM AUM UAM USM UUM.

Short-Duration Flights: J&H *thermal lag* generators are capable of delivering full-rated output throughout flight without benefit of cooling.

Long-Duration Flights: J&H *vapor-cooled* and *oil-cooled* generators using water and engine or hydraulic oil as coolants will deliver full-rated output regardless of speeds, ambients or altitudes.

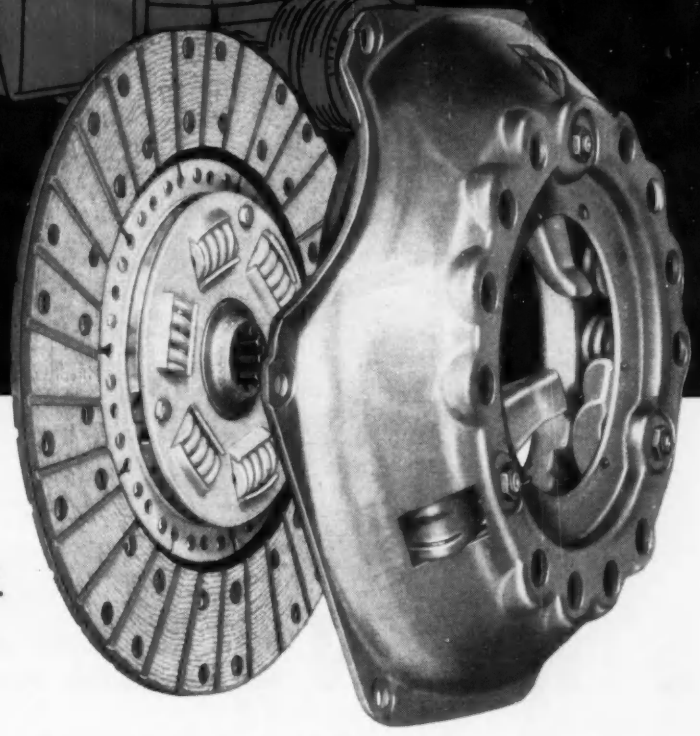
Representative J&H Generator Designs for Missiles	Vapor-Cooled	Oil-Cooled 	Thermal Lag 
J&H Model	G188-5	31190-005	31186-001
Nominal Rating (kva)	30	40	10
Duty	continuous	continuous	intermittent
Volts	120	120/208	120/208
Speed (rpm)	12,000	6,000	12,000
Phase	3	3	3
Frequency (cps)	400	400	400
Power Factor (minimum)	.8	.75	.9
Weight (lb)	66	75	29.5
Length (in.)	13	9	10
Diameter (in.)	9	9.75	7

To Meet Your Specific Needs: J&H missile power specialists are available to confer on your specific requirements . . . generators and regulators. You may obtain basic engineering data on other J&H environment-free generators by writing to Jack & Heintz, Inc., 17638 Broadway, Cleveland 1, Ohio. Export Department: 13 East 40th Street, New York 16, New York.

© 1956 by Jack & Heintz, Inc.

JACK & HEINTZ AIRCRAFT ELECTRIC EQUIPMENT

now light trucks haul heavier loads



thanks to

BORG-WARNER

engineering

Time was when light trucks weren't expected to handle anything but light loads. Today the demand is for light trucks with the ability and capacity to handle far heavier loads. But the greater the load, the greater the stress on the clutch. So the problem is to pack more "muscle" into the clutch without increasing its size or weight.

Through advanced design and creative engineering, Borg-Warner's Borg & Beck Division has developed a new three-lever clutch that's actually lighter and shallower than before, yet with up to 20% greater load capacity. Designed for high torque engines, it's smoother and quieter. Its arch type construction means better ventilation. It is self-adjusting, for minimum maintenance. And it's available in 10″, 10.5″ and 11″ sizes for a wide range of applications, both light truck and passenger car.

Precision built and thoroughly tested for balance and uniformity, this new Borg & Beck clutch is another typical example of the "design it better—make it better" thinking that goes into every Borg-Warner product.

Almost every American benefits every day from the products of

BORG-WARNER

B-W

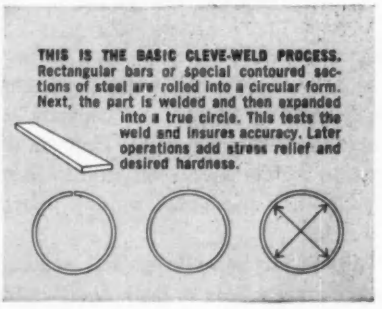
THESE UNITS FORM BORG-WARNER, Executive Offices, 310 S. Michigan Ave., Chicago • DIVISIONS: BORG & BECK • BYRON JACKSON • CALUMET STEEL • DETROIT GEAR • FRANKLIN STEEL • HYDRALINE PRODUCTS • INGERSOLL CONDITIONED AIR • INGERSOLL KALAMAZOO • INGERSOLL PRODUCTS • INGERSOLL STEEL • LONG MANUFACTURING • MARBON CHEMICAL • MARVEL-SCHEBLER PRODUCTS • MECHANICS UNIVERSAL JOINT • MORSE • PESCO PRODUCTS • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR • WOOSTER DIVISION • YORK • SUBSIDIARIES: B-W ACCEPTANCE CORP. • BORG-WARNER INTERNATIONAL • BORG-WARNER, LTD. • BORG-WARNER SERVICE PARTS • BYRON JACKSON OF CANADA, LTD. • EBERHARDT-DENVER CO. • LONG MFG., LTD. • MORSE CHAIN • MORSE CHAIN OF CANADA, LTD. • REFLECTAL CORP. • WARNER GEAR, LTD. • WESTON HYDRAULICS, LTD.

STRAIN can halt your customers' payloads when rims don't give top performance. Stop complaints. Specify Cleve-Weld as your primary rim source.

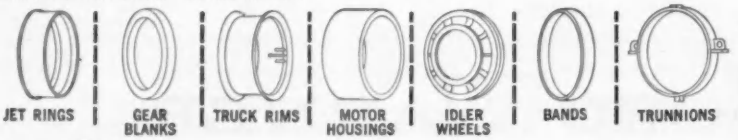
Cleve-weld rims are designed six ways better!

1. Rim thickened at strategic points... increases resistance to severe stresses.
2. Tapered beads on both sides of rim ...tire mates firmly with the rim.
3. 28° mounting bevel...enables rim to be mounted on all cast wheels.
4. Lightweight construction...means higher payloads for customers without loss of strength.
5. Tire rests on tapered bead seat...tire stays put when puncture occurs.
6. Designed for any brand or type of tire...flexibility ends tire replacement problems.

For 45 years Cleve-Weld has specialized in rolled and welded circular products...good reason why *you save when you specify Cleve-Weld as your primary source for all rolled and welded circular parts.* We'd like to talk it over. Write Circular Welded Products Sales Department at address below.


THIS IS THE BASIC CLEVE-WELD PROCESS.
Rectangular bars or special contoured sections of steel are rolled into a circular form. Next, the part is welded and then expanded into a true circle. This tests the weld and insures accuracy. Later operations add stress relief and desired hardness.

EXAMPLES OF CLEVE-WELD PROCESS PRODUCTS



Another AMF Product
CLEVE-WELD PROCESS
RIMS · RINGS · WELDMENTS

CLEVELAND WELDING DIVISION
AMERICAN MACHINE & FOUNDRY COMPANY
Cleveland 11, Ohio

SEND THIS COUPON NOW

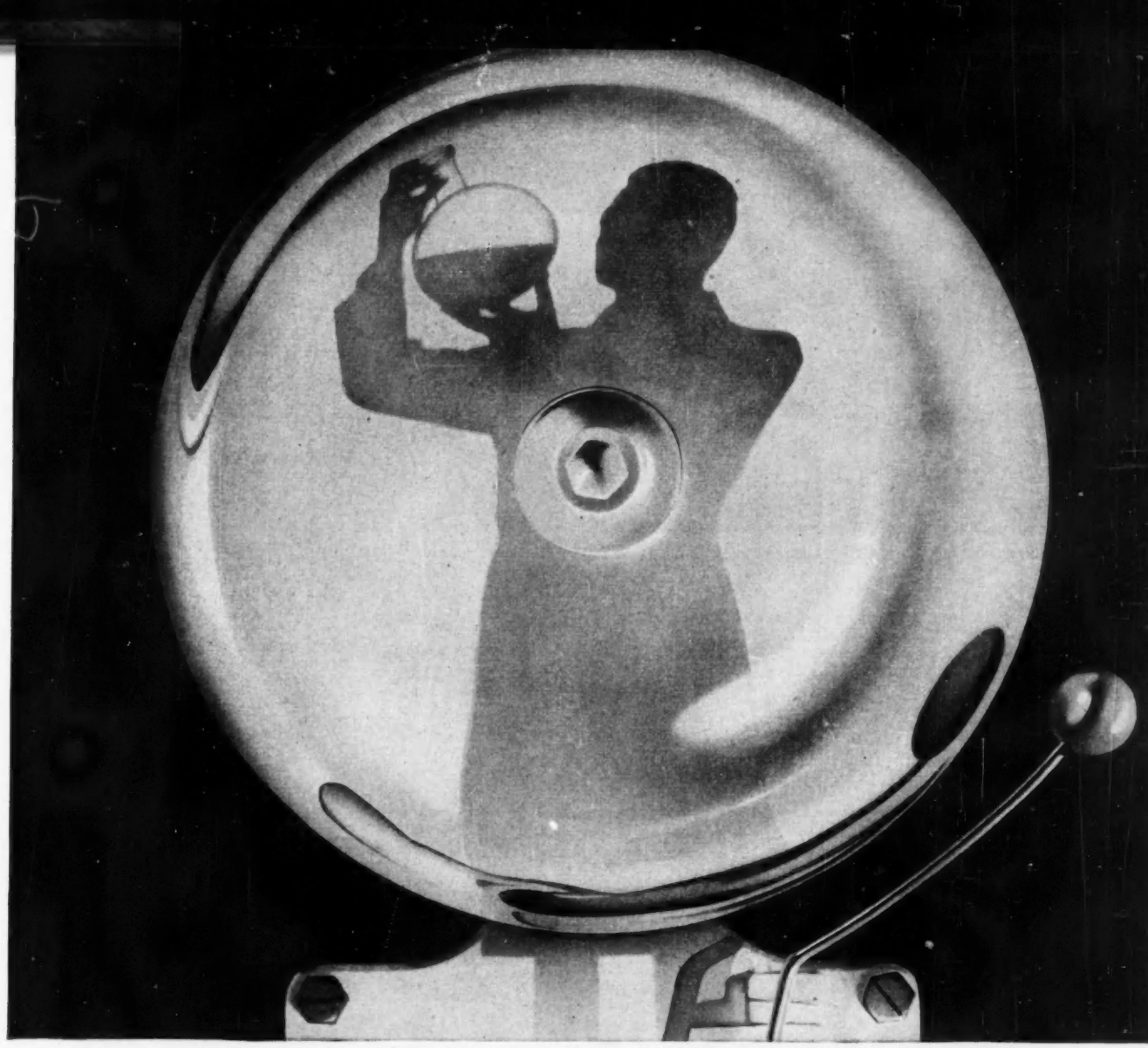
Cleveland Welding Division
American Machine & Foundry Company
West 117th Street and Berea Road
Cleveland 11, Ohio Dept. SAE-612

Please send me:
- ☐ Truck Rim Catalog
- ☐ Tractor Rim Catalog
- ☐ Brochure on Cleve-Weld Process

Name_____

Title_____

Attach to your company letterhead and mail



matching wits with fire

Fire-resistant Celanese Cellulubes provide protection against the costly damage of fires and explosions.

When employed as the hydraulic fluid in die casting and similar critical operations, Cellulubes reduce the ever-present danger of uncontrollable fires caused by line breaks or other equipment failures. As air cylinder lubricants in compressed air systems, Cellulubes prevent the formation of excessive carbon deposits—the main source of compressor fires and explosions.

Possessing stable physical properties, Celanese Cellulubes provide high performance and safety during continuous duty under critical conditions. This stability contributes to the fluid's longer life, an economy factor further enhanced by the fluid's reusable property, permitting reuse of spillage. Straight phosphate esters, Cellulubes contain no additives. They're non-reacting, non-carbon-forming, non-corrosive, fire-resistant chemical compounds with excellent lubricity.

Available in 6 controlled viscosities, Cellulubes can be supplied by Celanese to meet exacting requirements in the replacement of flammable fluids presently in use. Play it safe, write for complete data and technical assistance.

Celanese Corporation of America, Chemical Division, Dept. 598-L, 180 Madison Avenue, New York 16, N. Y.

Basic reasons.....

Acids
Alcohols
Aldehydes
Anhydrides
Esters
Functional Fluids
Gasoline Additives
Glycols
Ketones
Oxides
Polyols
Plasticizers
Salts
Solvents
Vinyl Monomers

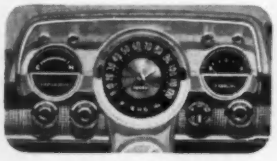
Celanese CHEMICALS

.....for improved products

Agricultural, automotive, aviation, building, electrical, paper, pharmaceutical, plastics, surface coatings, textile.

1. NEWEST AUTOMATIC DRIVE OF ALL

2. PERFORMANCE REACHES NEW HIGHS

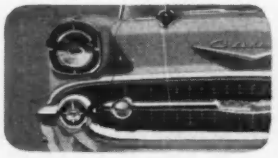


3. COMMAND POST CONTROL PANEL

4. LOOKS LONGER . . . AND IT IS!

5. HEADLIGHT-HOOD AIR INTAKES

6. NEW SIZE WHEELS AND TIRES



7. DRAMATIC NEW FRONT END DESIGN

1. NEWEST AUTOMATIC DRIVE OF ALL
It's Turboglide* with new Triple-Turbine take-off! Chevrolet also offers an even finer Powerglide.*

2. PERFORMANCE REACHES NEW HIGHS
A superb 6 and four silken V8's with up to 245 h.p. Also a special 270-h.p. V8 and fuel injection engines with up to 283 h.p. available at extra cost.

3. COMMAND POST CONTROL PANEL
A deeply hooded cove, directly in front of the driver, houses all instruments, controls and gauges.

4. LOOKS LONGER . . . AND IT IS!
Those longer, lower lines are no illusion. The '57 Chevrolet measures up to them. It *is* longer, lower—and every inch a beauty!

5. HEADLIGHT-HOOD AIR INTAKES
Here's a smart idea—ventilation air intakes cap the headlights for a new note in styling. And it's clean high-level air, too.

6. NEW SIZE WHEELS AND TIRES
Chevy now has 14-inch wheels, 7.50 x 14 tires. The velvety ride is even softer because air pressure is reduced to a new low of 22 pounds.

7. DRAMATIC NEW FRONT END DESIGN
The front bumper is combined with the grille for new massiveness and uncluttered purity of line.

**Optional at extra cost*

THERE'S THE GREATEST CHANGE IN CHEVROLET!

Bold new beauty—the Bel Air Sport Coupe

For '57, Chevrolet comes up with a dramatic new departure in design! Plus new power (even fuel injection!), a new automatic drive, new ideas right down to the wheels it rolls on. It's Sweet, Smooth and Sassy!

Chevrolet's great design team has come up with a whole galaxy of sparkling new advances. You can *see* that a block away, in Chevy's proud new bumper-and-grille front, in the bold flare of its rear fenders, the clean-lined simplicity of its integrated taillight assembly. You can *feel* the difference, instantly, the moment you nudge the accelerator on any of Chevy's superb new engines. Matter of fact, there's so much that's new and wonderful about this new Chevy you can spend fascinating hours just getting acquainted with 1957's most distinctive car. . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

Mr. Designer:
Don't give up that
bold idea until
you talk to "U. S."
Molding experts

With U. S. Molded & Engineered Products, designers find they can do things impossible with any other material. Particularly in the field of precision molding in mass production, problems in flexing, in product thickness, in uniformity and consistency all become far easier or disappear entirely. The designer, free of the shackles imposed by other materials, can set his sights for exciting new horizons in design and construction.

"U.S." expertly molds precision rubber parts with any or all of these important properties: compression recovery—resistance to acid, various chemicals, oil, water—hot or cold tear-resistance—required tensile strength and elongations.

"U.S." factory-trained engineers will help you solve any molded rubber problem. Contact U.S. Rubber, Automotive Sales, Mechanical Goods Division, New Center Bldg., Detroit 2. Telephone TRinity 4-3500.

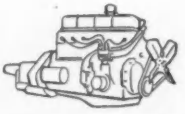
Watch NCAA football, Saturday afternoons, NBC-TV

US RUBBER

Mechanical Goods Division

United States Rubber

Imagineering the 195X models . . . in Alcoa Aluminum



Are solid aluminum bearings the key to stiffer, better balanced crankshafts?

Someday soon, engineers will design an automobile engine using aluminum bearings for connecting rods and mains. They'll be solid aluminum.

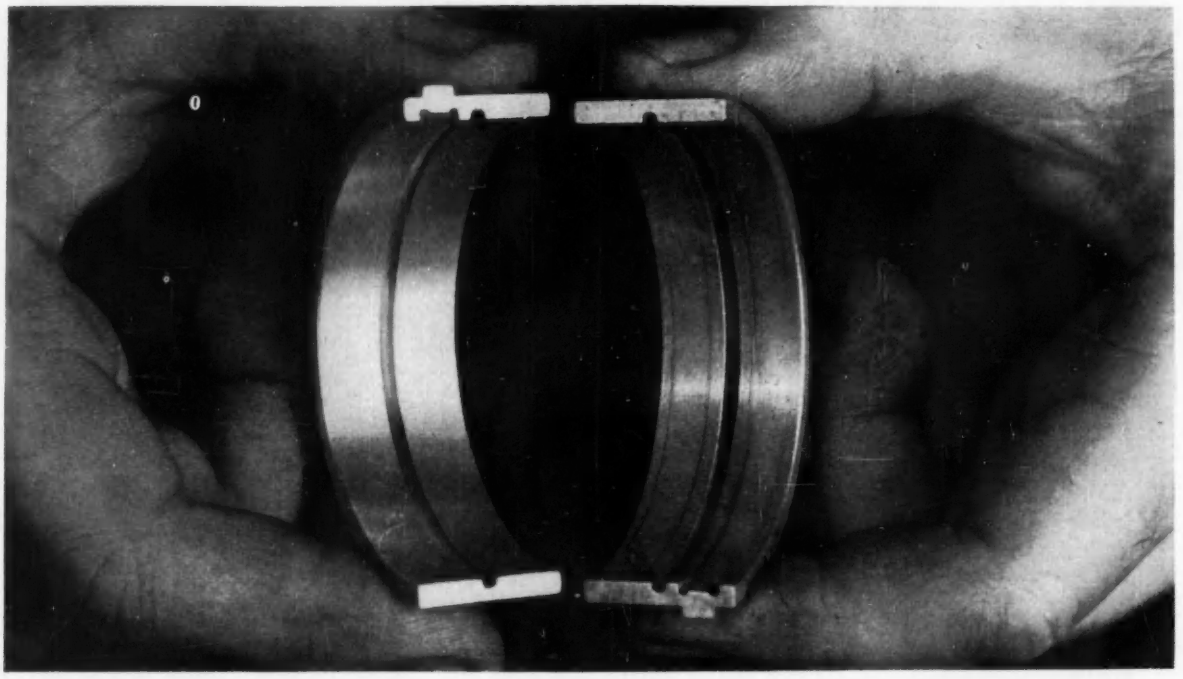
This new engine will be better and more economical because solid aluminum bearings will make it possible for engineers to design a better crankshaft. Here's why that's true:

Solid aluminum bearings carry very high loads. In a nonautomotive engine now widely used, aluminum bearings are supporting 10,000 psi. This is far more than automotive bearings now support. It means that aluminum can support the loads that result from higher horsepower. But more important, it means that with aluminum, the bearing area can be reduced.

Cutting down on bearing area allows you to put more metal in the crankshaft web. This results in a stronger, stiffer, more durable crankshaft. More throw space is available for balancing. Main bearing saddles are narrower, improving alignment and increasing strength.

Aluminum offers these bonus benefits. Additives in some extreme pressure lubricants corrode many metals but have no effect on aluminum bearings. And very important, aluminum is a good conductor and carries away heat fast. Bearings can be operated at higher temperatures.

We know that someday soon, *some* engineers are going to get a better engine by designing for aluminum bearings. When they do, the Alcoa Development Division will be the place to go for help in imagineering better bearings for 195X (or '6X) models . . . from Alcoa® Aluminum.



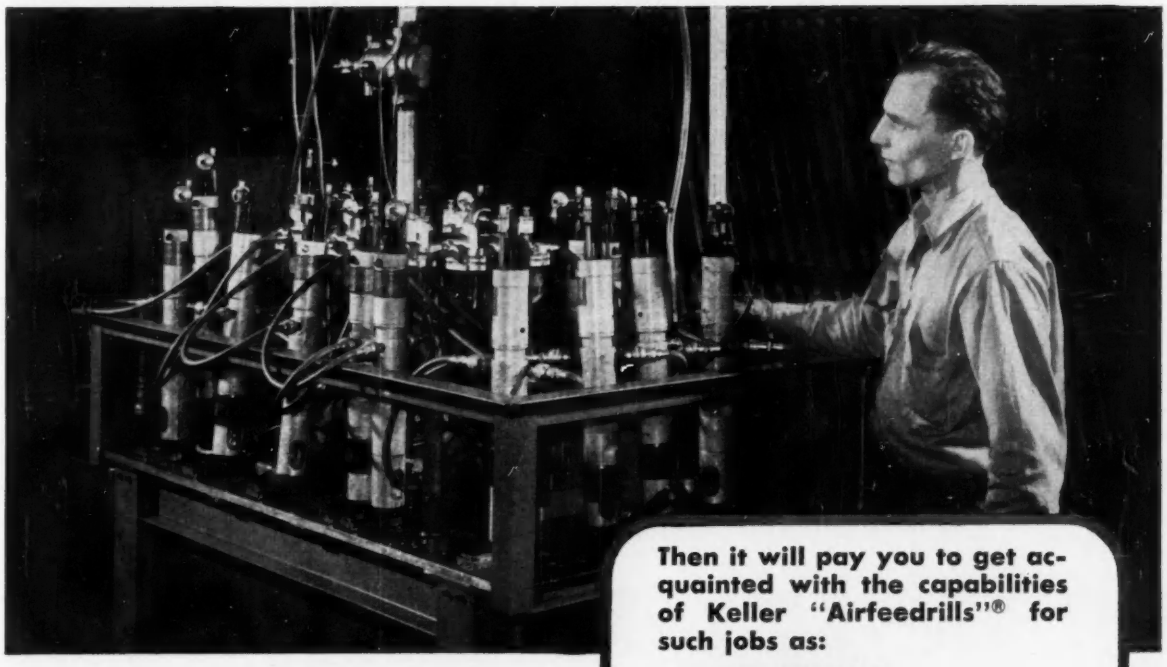
Alcoa engineers took a standard production engine and installed main and connecting rod bearings of solid aluminum. At the end of a test equivalent to 150,000 miles driving, all the bearings were in good condition. At the left is a brand-new bearing. At the right is a bearing used in the test. Suggestion: For better bearings, let our superbly equipped Development Division help *you* imagineer solid aluminum bearings. Aluminum Company of America, 1844-M Alcoa Building, Pittsburgh 19, Pa.

THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

Always Fasten Aluminum With Alcoa Aluminum Fasteners

Your Guide to the Best in Aluminum Value

Can automatic production help you improve quality . . . *reduce costs* ?



A typical automatic production setup using 14 Keller "Airfeedrills." Pressing a single control valve drills 14 holes simultaneously in a refrigerator outer shell assembly—the drills advance, drill, retract, and shut off automatically.

■ These remarkable tools work without supervision, and take the place of expensive machines in automation setups. They are entirely air controlled and operated, automatically cycled, and extremely accurate.

■ Among the special advantages available are sensing type rapid advance, hydraulic feed control, and adjustable torque control. Thus they are able to do peck drilling, skip drilling, and other jobs that heretofore have required expensive machine tools.

■ Write and tell us about your machining problems. We will send appropriate bulletins or have a representative call to discuss Keller Air Tools.

Then it will pay you to get acquainted with the capabilities of Keller "Airfeedrills"® for such jobs as:

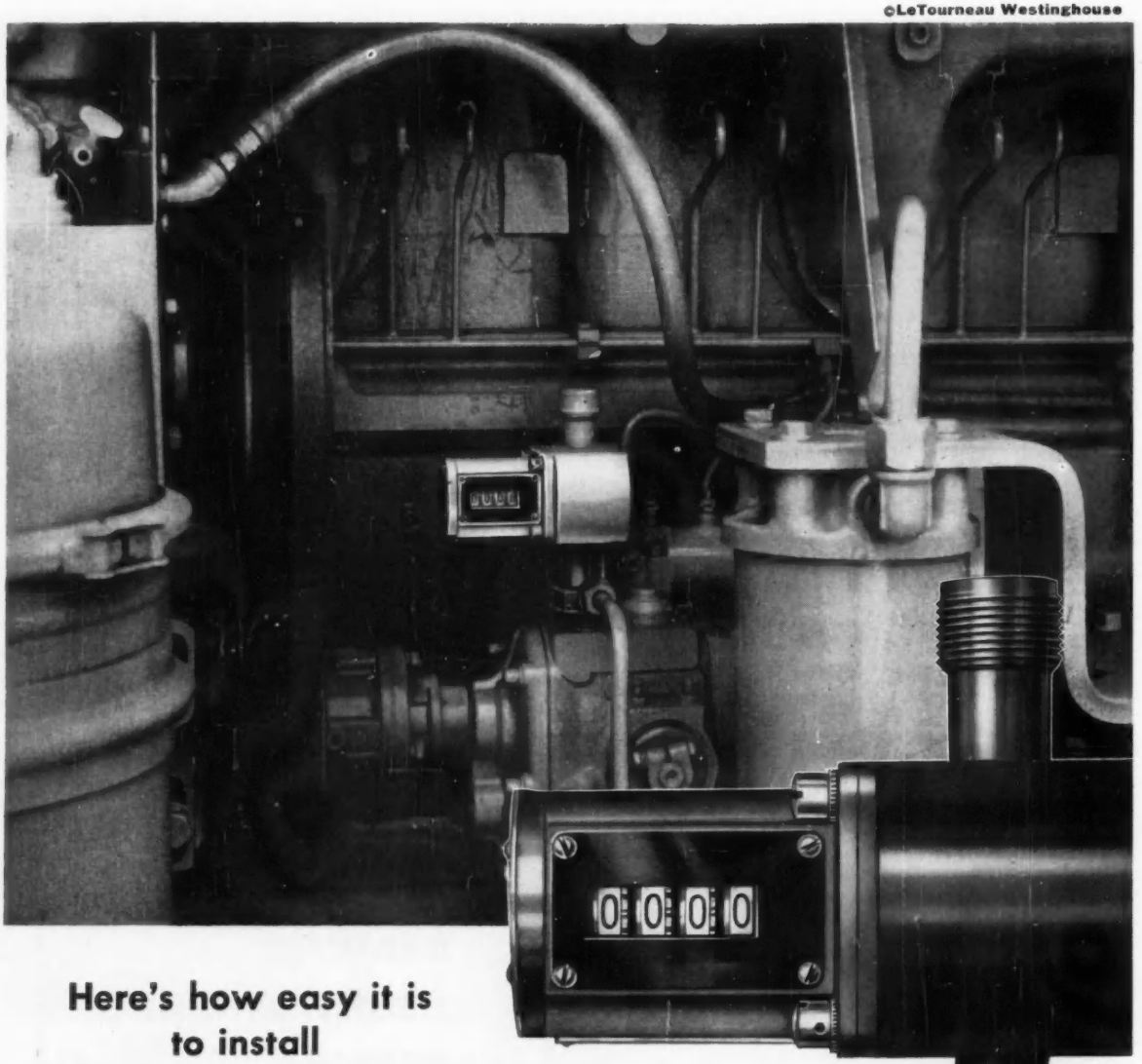
- **DRILLING**
- **REAMING**
- **COUNTERSINKING**
- **TAPPING**
- **CENTER DRILLING**
- **CHAMFERING**
- **COUNTERBORING**
- **SPOTFACING**

GARDNER-DENVER

KELLER TOOL division, Grand Haven, Michigan

THE QUALITY LEADER IN COMPRESSORS, PUMPS, ROCK DRILLS AND AIR TOOLS FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

©LeTourneau Westinghouse



Here's how easy it is to install

VEEDER-ROOT

Rev-Counters

...with the New "Tach Take-Offs"

On any engine having a tachometer take-off, Veeder-Root Rev-Counters can be installed in a position which is readily accessible for easy reading . . . so the man who reads the counter doesn't get all messed up or get a crick in his neck.

In fact, with these new attachments, Veeder-Root Rev-Counters make it easy for anyone to see how your equipment is living up to its guarantee . . . when routine maintenance is coming due . . . and to get other valuable facts-in-figures.

You can count on Veeder-Root to help you engineer these adaptable counters not only into engines, but into generators, compressors, heaters, and other equipment. And you will find . . . as other manufacturers of power-units have found . . . that when you build in Veeder-Root Counters, *you build up sales.*

Everyone... Can Count on

VEEDER-ROOT INC.

"The Name that Counts"

Hartford, Conn. • Greenville, S. C.
Chicago • New York • Los Angeles
San Francisco • Montreal
Offices and Agents in other Principal Cities

XVIII

This is the eighteenth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Methods of Carburizing Alloy Steels

Carburizing is a means of impregnating the surface of steel with carbon, usually to very limited depths. Its purpose is to provide a hard, wear-resisting "case," or outer shell. Alloy steels, correctly handled, can be case-hardened without sacrificing desirable core properties.

There are three types of carburizing in general use. These will be discussed briefly in the following paragraphs:

Liquid Carburizing—The medium here is a hot salt bath composed basically of cyanide compounds. The steel is immersed in the bath, the period of immersion depending upon the analysis of the steel and the depth of case desired. Liquid carburizing produces a thin, hard, wear-resisting case with a maximum practical depth range of 0.02 to 0.03 in. When the steel is quenched directly from the bath, distortion is low.

Gas Carburizing—This method employs a furnace in which a carbonaceous atmosphere is created; i.e., gases that are high in carbon components, or those containing carbon. Steel subjected to gas carburizing can be case-hardened to depths generally ranging from 0.01 to 0.04 in. When quenching takes place immediately after carburizing, distortion can be kept to a minimum.

Pack Carburizing—Where the pack method is used, the parts to be carburized are buried in a container of dry carbonaceous materials. The container is sealed tight to prevent the infiltration of air, placed in a furnace and kept there for eight hours or more, the actual time depending upon the depth of case desired. Pack carburizing is particularly suitable where a deep case is essential (0.06 in. and over), although medium cases in the 0.04-to-0.06-in. range are possible.

The carburizing of alloy steels is a highly technical subject, and Bethlehem metallurgists will be glad to help you with any phase of it. Feel free to consult with them about the results to be expected from various analyses and the various methods of treatment. And when you are in the market for alloy steels of any kind, please bear in mind that Bethlehem Steel makes the complete range of AISI standard grades of alloy steels, as well as special-analysis steels and all carbon grades.

If you would like reprints of this series of advertisements from No. I through No. XVI please write to us, addressing your request to Publications Dept., Bethlehem Steel Company, Bethlehem, Pa. The first 16 subjects in the series are now available in a handy 32-page booklet, and we shall be glad to send you a free copy.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

Proven

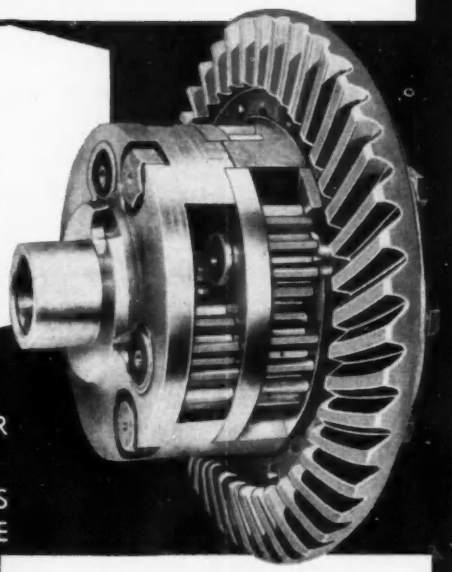
by MILLIONS OF MILES OF EVERYDAY USE BY CUSTOMERS!

NEW IMPROVED

Dualoc

POWER-DIVIDING

Differentials



. . . AFFORDS GREATER SAFETY AND ECONOMY FOR PASSENGER CARS!

. . . SUPPLIES MORE USABLE TRACTION FOR TRUCKS AND OFF-THE-ROAD EQUIPMENT UNDER ADVERSE OPERATING CONDITIONS.

Annoying stalls resulting from one wheel spinning in snow, mud and on ice covered surfaces are eliminated by the transfer of power between rear wheels controlled by the Dualoc Differential. Vehicle positively will move out of stalled position if either wheel has traction or up to the critical point where both rear wheels spin.

DYNAMOMETER TESTS
Show Power Dividing Ratio of 14 to 1

INPUT SPEED	RIGHT SPEED	LOAD #	LEFT SPEED	LOAD #
500	108	10	118	10
Approx.	80	10	80	20
	88	10	84	30
	70	10	82	40
	96	10	100	50
	92	10	92	60
	78	10	76	70
	88	10	90	80
	76	10	80	90
	102	10	100	100
	105	10	108	110
	92	10	97	120
	68	10	70	130
		10	0	140

ATTENTION:

EXECUTIVES • DESIGN ENGINEERS

This Advance INNOVATION in DIFFERENTIALS will be Exhibited in Booth #5 at the S.A.E. Display — January 14-18 — Sheraton Cadillac Hotel, Detroit, Michigan.

CONTROLLED POWER — TRADE MARK

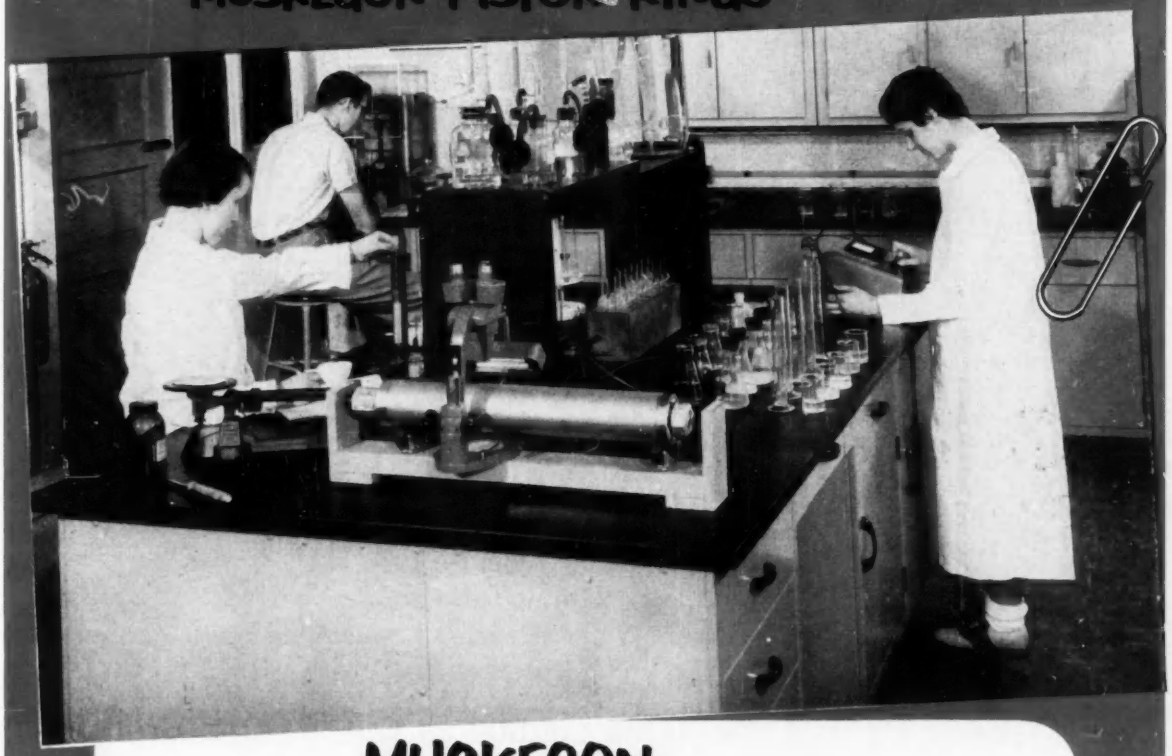
Dualoc Drive, inc.

700-20th St., Rockford, Ill.

Manufacturers of Fine Power-dividing Differentials

YEAR AFTER YEAR... MODEL AFTER MODEL...

MORE THAN ONE OUT OF THREE CARS ARE EQUIPPED WITH MUSKEGON PISTON RINGS



BECAUSE MUSKEGON HAS WHAT IT TAKES

FOR QUALITY, QUANTITY RING PLATING

Plating is an art at Muskegon! Skilled craftsmen carefully control plating baths to produce precision plating for longer life, greater ring efficiency. There is no sacrifice of quality for volume — yet quantity plating is done as a matter of course at Muskegon.

But plating is only one part of the Muskegon story. It starts with engineering design and development coordinated with the engine builders' engineering staff, and continues through the world's largest ring foundry, complete finishing production and inspection facilities. These have all helped put Muskegon rings in more than one of three cars produced, year after year. If your ring design demands special coating or plating, why not see Muskegon today?

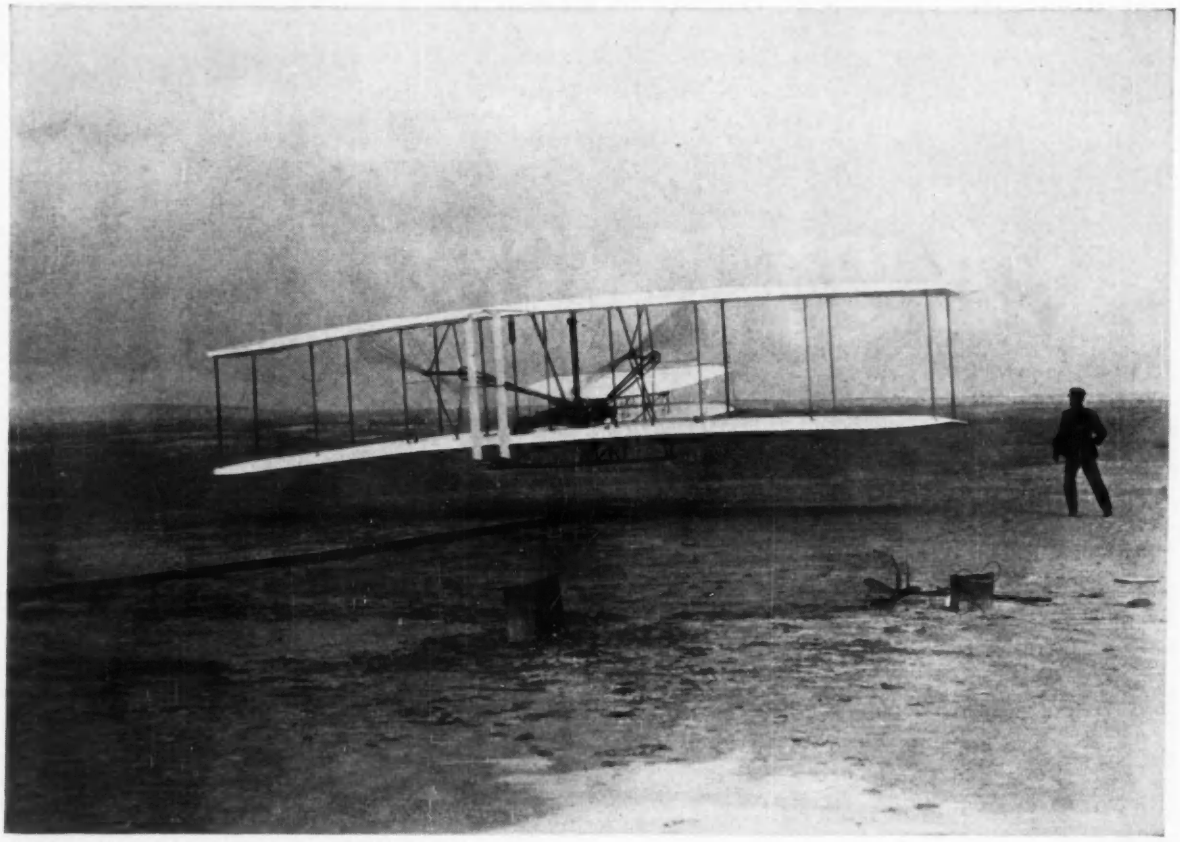
No matter what the design of the individual rings needed to fill the grooves of your piston, rely on Muskegon as your source.

DETROIT OFFICE:
521 New Center Building
Telephone: Trinity 2-2113

MUSKEGON Piston Rings

MUSKEGON PISTON RING CO.
MUSKEGON, MICHIGAN
PLANTS AT MUSKEGON AND SPARTA

Since 1921 ... The engine builders' source!



Experiment by two bicycle mechanics, Kitty Hawk, 1903

BETTMANN ARCHIVE

Ever wished you had the same chance as the Wright Brothers?

You have—in missile engineering!

The Wright Brothers found existing aerodynamics concepts to be unreliable—so they formulated their own. By this ability to see further than accepted doctrine they started the mainstream of aviation development on its way. It is this power to reach beyond standard ideas that has led through every major advance in aeronautical science right up to the remarkable progress now going on in missile engineering.

If *you* have this desire to 'reach beyond' you should be with us right now. You'll find no better place to master the problems of very high speed, global-range flight.

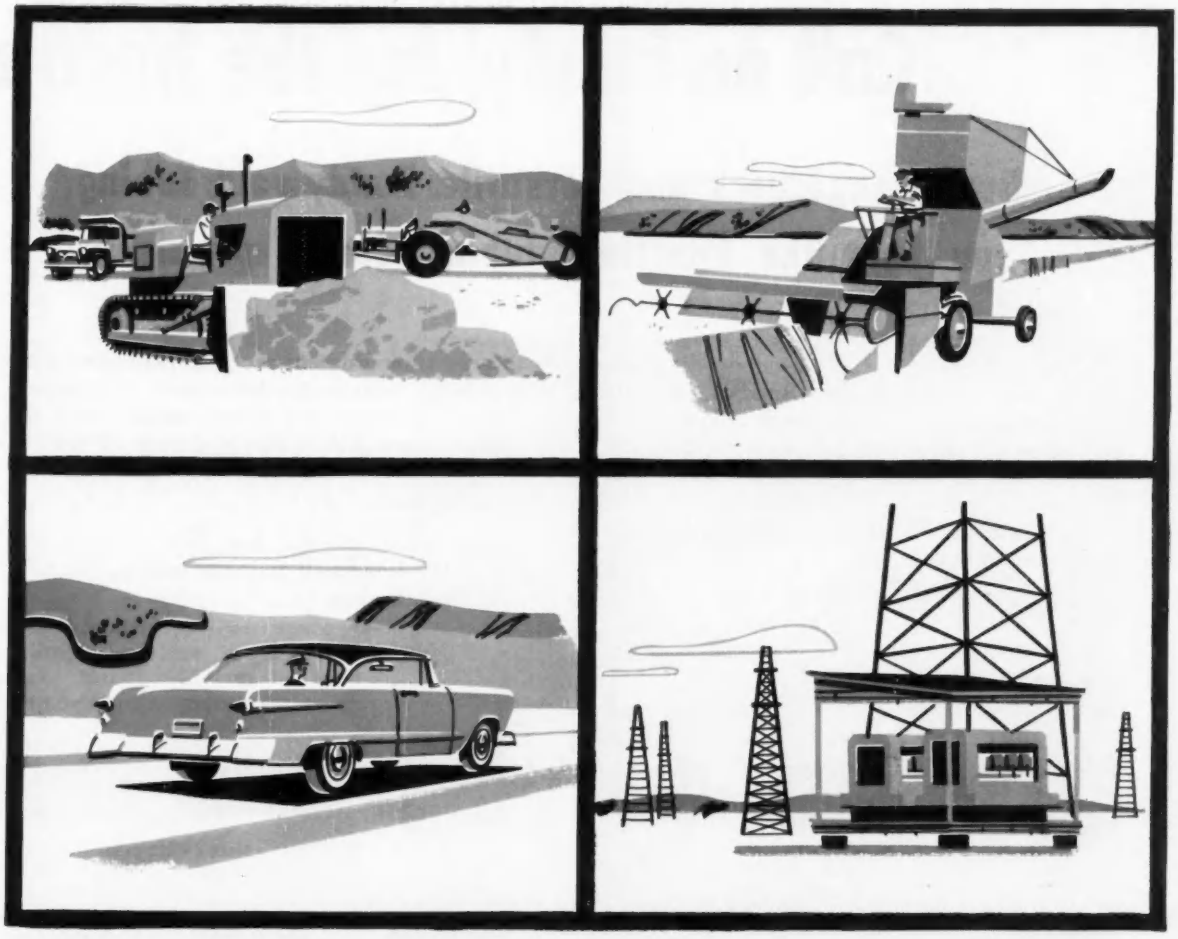
Here at North American, we are pioneers in this new era of flight. A supersonic test vehicle, the X-10, is already flying. As a leader in advanced weapons systems, we have the prime responsibility for the SM-64 Navaho Intercontinental Missile. This program is unique because it is *fully integrated;* it covers every aspect of Missile Engineering—including the most advanced developments in supersonic airframe design and manufacture, guidance and control systems, jet and rocket engines, and flight testing.

IF YOUR SPECIALTY IS LISTED HERE, WRITE TODAY FOR OUR FREE BROCHURE:

Instrumentation Design, Development & Application Standards, Drawings Checking, Specifications Writing
High Temperature Materials Engineering Structures, Stress, Flutter and Aeroelasticity Missile Airframe Design
Component and System Reliability Engineering Aerodynamics Thermodynamics Hydraulic, Pneumatic and Servo Engineering
Guidance and Flight Control Systems Evaluation Systems and Components Testing Missile and Ground Power
Engineering Flight Test Launching Equipment Field Service and Technical Training

THE ADDRESS: Mr. M. Brunetti, Engineering Personnel Dept. 91-12SAE
Missile Development Division, 12214 Lakewood Blvd., Downey, California

NORTH AMERICAN AVIATION, INC.



Bearings for industry

FEDERAL Mogul
SINCE 1899

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11035 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

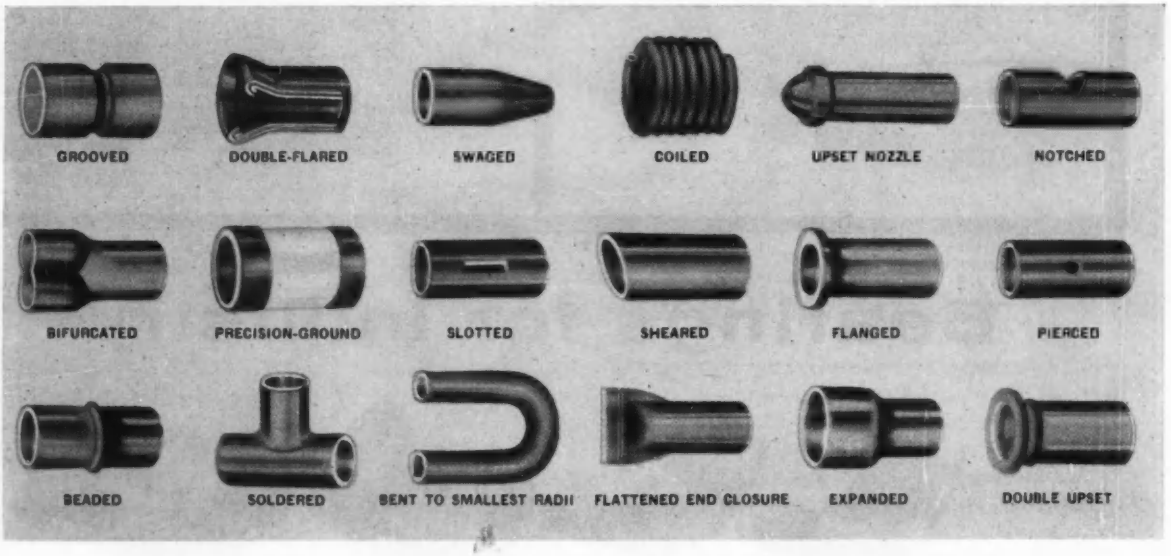
Call on Bundy for the best in

Bundy engineers and versatile Bundyweld Tubing can beat the knottiest tubing design problems

IF YOU think it can't be done with tubing, it's a challenge to Bundy®. For years, Bundy engineers have specialized in working with customers and prospects, solving the insolvable. A unique combination of imagination and experience, plus the extreme versatility of Bundyweld® Steel Tubing, has paid off again and again.

Check first with Bundy for workable solutions to your tubing design problems. Whether you are in the design, developmental, or application stage of your product, Bundy will be glad to work with you. Hundreds of manufacturers have already used this Bundy service to advantage.

For instance, if your particular product involves bending small-diameter tubing, you will find, at right, how . . .



Shown above are but a few of the fabrication operations which are possible with Bundyweld Steel Tubing. Many of these, and others not shown, were developed through solving a specific problem brought to us by a customer or prospect. At any stage in the development of your product, Bundy invites you to take advantage of this design service.

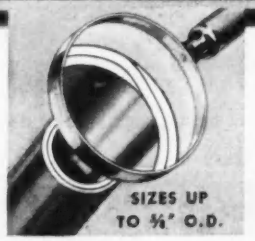
BUNDYWELD IS DOUBLE-WALLED FROM A SINGLE STRIP

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.



NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

tubing, design help, and fabrication

New mass-produced return bends help you solve design problems where space is limited

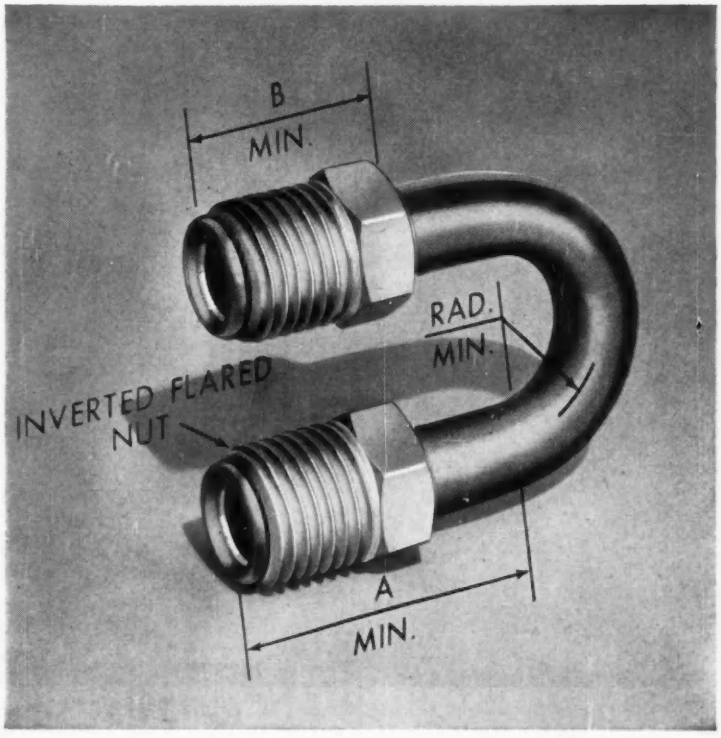
DESIGNING hydraulic actuators for automotive and other uses involves bending tubing to minimum radii, because of severe space limitations in small hydraulic "packages."

At the request of leading fabricators, Bundy has established new minimum standards for the mass production of return bends with fittings attached, in tubing from $\frac{3}{16}$" to $\frac{5}{8}$" O.D. For special problems, where space is more important than speed of production, Bundyweld can be fabricated to even closer tolerances.

Bundyweld Tubing takes such fabrication easily because it's the only tubing double-walled from a single metal strip, copper-bonded through 360° of wall contact. The result: stronger tubing that withstands heavy vibration fatigue, has high bursting strength and high thermal conductivity. No wonder Bundyweld is the accepted standard of the refrigeration and automotive industries: *it is used in 95% of today's cars, in an average of 20 applications each.*

Add Bundy's expert, free engineering service, and you know why Bundyweld Tubing solves even the most difficult tubing problems. Call, write, or wire us today!

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



TUBE O.D.	3/16	1/4	5/16	3/8	7/16	1/2	5/8
RAD.-MIN.	5/16	3/8	5/8	3/4	7/8	1	1 1/2
A-MIN.	3/4	7/8	1	1 1/16	1 1/8	1 1/4	1 3/8
B-MIN.	5/8	5/8	11/16	23/32	3/4	13/16	7/8
Bundy Part No. of S.A.E. St'd Inverted Flared Nut	P-2208	P-2205	P-2206	P-2207	P-2266	P-2267	P-2359

BUNDYWELD® TUBING

Bundy Tubing Distributors and Representatives: *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Los Angeles 58, Calif.:* Tubesales, 5400 Alcoa Ave. • *Philadelphia 3, Penn.:* Rutan & Co., 1717 Sansom St. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 4755 First Ave., South *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.**

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY

Spring steel within this range...

FOR THE MOST EXACTING NEEDS KNOWN TODAY!

• That this is the age of specialization is certainly true in the use of steels. And in this regard *Athenia Steel* customers benefit especially by two not-too-common factors. First, by extreme control of quality and uniformity, unsurpassed, seldom equalled *anywhere!* Secondly, by painstaking technical service to determine or develop precisely the right steel for any special need.

Here at Athenia we concentrate on cold rolled high carbon flat steels, custom made of .45 carbon and higher, in widths from .015″ to 16″ and thicknesses from .001″ to .065″. Full range of finishes and tempers. We also produce special narrow width stainless, and the new super-tough, corrosion resistant spring material, Nilcor*.

For a new and profitable experience in service and in steel controlled precisely to *your* needs... try us!

*Trade Mark National-Standard Company

NATIONAL-STANDARD COMPANY • NILES, MICHIGAN
Tire Wire, Stainless, Fabricated Braids and Tape

ATHENIA STEEL DIVISION • CLIFTON, N. J.
Flat, High Carbon, Cold Rolled Spring Steel

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WAGNER LITHO MACHINERY • JERSEY CITY, N. J.
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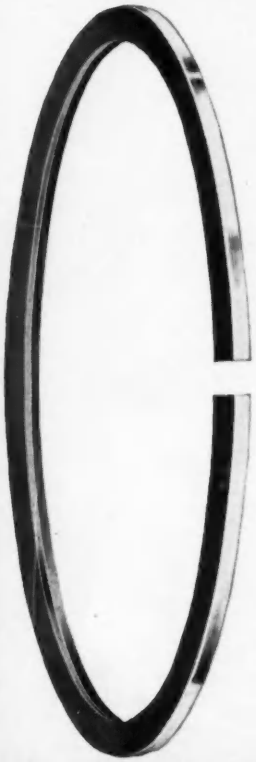
WORCESTER WIRE WORKS DIVISION • WORCESTER, MASS.
Round and Shaped Steel Wire, Small Sizes

Diesel Engines need Sealed Power Cyclan Piston Rings because...



Cyclan rings will not break in service.

Cyclan rings show 70% less wear than cast iron rings.

Cyclan rings have the impact strength to deflect without damage.

Cyclan rings retain tension under high operating temperatures.

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Sealed Power Piston Rings

PISTONS • CYLINDER SLEEVES

Leading Manufacturer of Automotive and Industrial Piston Rings Since 1911
Largest Producer of Sealing Rings for Automatic Transmissions and Power Steering Units

in a new car . . .
in a used car . . .

stainless steel sells and re-sells

The Stainless Steel trim, molding and vital parts that add style and beauty to a car, inside and out, are features that help make the sale.

Stainless Steel has wide customer acceptance. It's easy to clean and keep clean. It's a tough, solid metal that will not corrode or dent and stands up to gravel, ice, salt and water.

The finish never fades and parts are easy to replace. Stainless Steel lasts the life of the car. It *sells* in a new car and it *re-sells* in a used car.

McLOUTH STAINLESS STEEL

for automobiles

McLOUTH STEEL CORPORATION
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Manufacturers of Stainless and Carbon Steels

AT CARTER . . .

die casting

metals testing

field service

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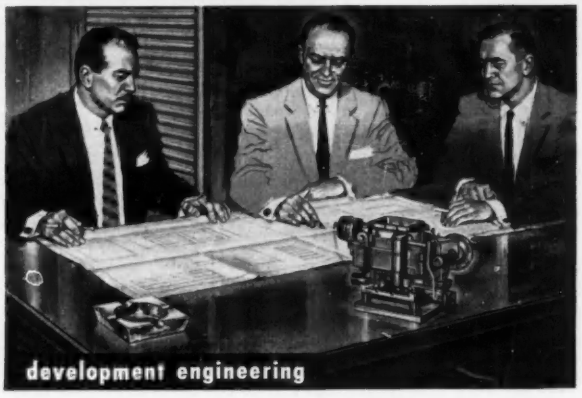
development engineering

A combination

of creative engineering, experience,
skills and product development
to serve your automotive needs today
. . . and plan for your tomorrows.

CARTER CARBURETOR

DIVISION OF acf INDUSTRIES, INCORPORATED • ST. LOUIS 7, MISSOURI

ENGINEERS

WE'RE LOOKING FOR MORE "TOMORROW THINKERS"

...AT REPUBLIC AVIATION

In a recent newspaper statement, Mundy I. Peale, President of Republic Aviation Corporation, stressed the increasing need in the aviation and missile industry for "men whose minds can really range the universe in complete intellectual freedom . . . what might be called 'Tomorrow Thinkers'."

The emphasis, of course, has always been on NEW IDEAS at Republic. For a quarter of a century this company has been in the forefront of aviation design, developing and building such planes as the most advanced supersonic fighter-bomber in the U. S. Air Force, the new F-105 Thunderchief—newest of the famous family of Thunder-Craft.

The pace of invention and discovery must be stepped up, in line with national necessities. Breaking the sound barrier—so tremendous an achievement only yesterday—is taken for granted today. Now the urgent need faced by Republic's designers of aircraft and missiles is to conquer the thermal barrier and the fantastic problems of hypersonic flight—and tomorrow, what new urgencies will confront us?

Practical engineering, important as it is, is not enough. We need an increasing number of engineers and scientists of inventive capacity, who are able to produce totally new theories in many fields, breaking the bonds of traditional thought. In short: "TOMORROW THINKERS."

We have many engineers and scientists with bold creative minds at Republic...and we need MORE men of this calibre. Company activities and scientific challenges are *both* expanding.

We invite professional men at all levels of experience, who feel qualified to contribute to the future of aviation, to a friendly interview...and we promise the men selected a professional working climate in which their ideas can thrive.

IMMEDIATE OPENINGS IN THESE FIELDS

Aerodynamics • Flight Test • Dynamics • Thermodynamics • Electronics • Flutter & Vibration • Servos • Weights • Weapons Systems Analysis • Analog & Digital Computers • Airframe & Mechanical Design • Antennae • Fire Control Systems • Flight Control Systems • Instrumentation • Stress Analysis • Operations Research • Preliminary Design • Systems Engineering • Propulsion • Publication Engineering

Please address complete resume of your technical background to:

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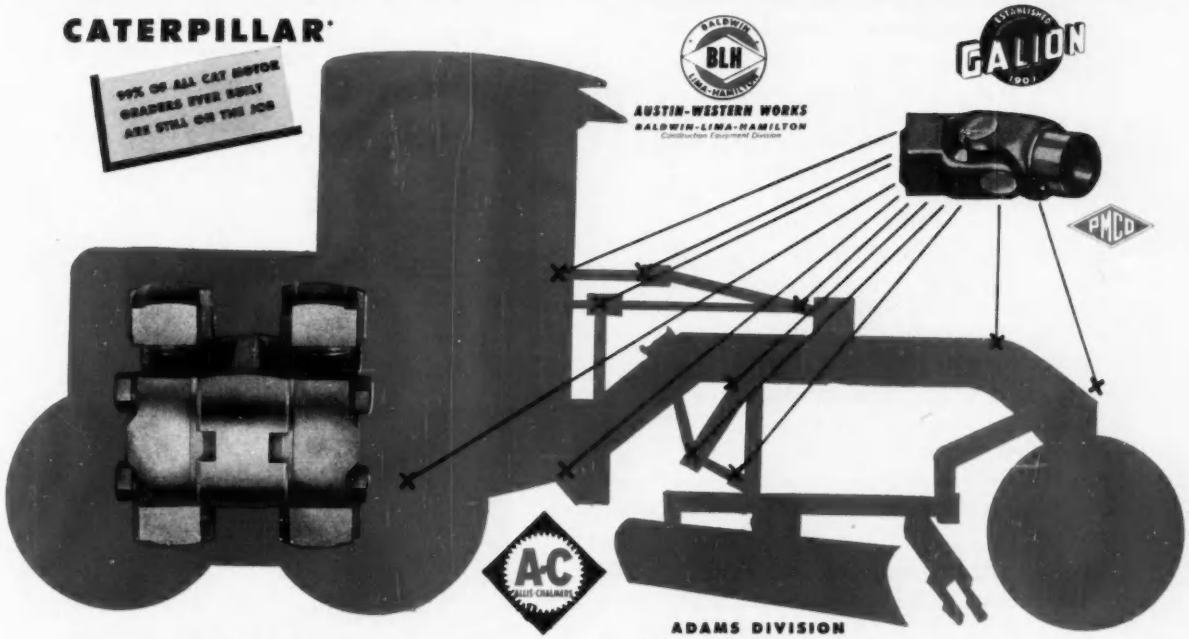
Engineering Personnel Manager MR. DAVID G. REID
Farmingdale, Long Island, N. Y.

MISSILES
Administrative Engineer MR. ROBERT R. REISSIG
223 Jericho Tpke., Mineola, Long Island, N. Y.

REPUBLIC AVIATION

RELIABLE



TRADE CHAMPION MARK

Whether for close-coupled main drive lines or for exposed steering and adjustment drives, designers with JOINT problems have learned to rely on MECHANICS. Where joints must run all day at high angles — where there are severe shock loads— where wide angles and long slip are common — and where dirt and/or moisture constantly are present — MECHANICS Roller Bearing UNIVERSAL JOINTS are the accepted solution. *Lubrication is so tightly sealed in that dirt and moisture cannot enter.* If you have a "tough" joint problem, make use of MECHANICS field engineers' wide experience.

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MECHANICS
Roller Bearing B-W
UNIVERSAL JOINTS
For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

How to Control Corrosion on Bare Aluminum

Corrosion is a real threat to aluminum, especially to the higher strength alloys. It can be controlled by using a chemical surface treatment, with results as dramatically effective as those shown in the illustrations at the right.

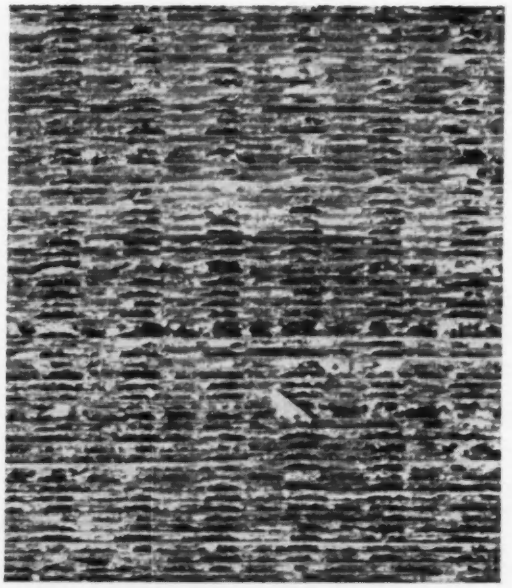
The corrosion protection is effected by Bonderite 710 or 720, applied by spray, immersion, or brush-on methods. A thin, iridescent coating, light to golden brown depending on the alloy treated, covers all surfaces of the aluminum and protects it against corrosion.

The coating produced by Bonderite is integral with the metal itself. It is flexible and can withstand moderate draws without difficulty. Arc and spot welding fabrication methods need not be changed, because the coating conducts electricity. It has good resistance to bimetallic and galvanic corrosion. Sheets, castings, forgings, extruded and rolled structural forms may be treated.

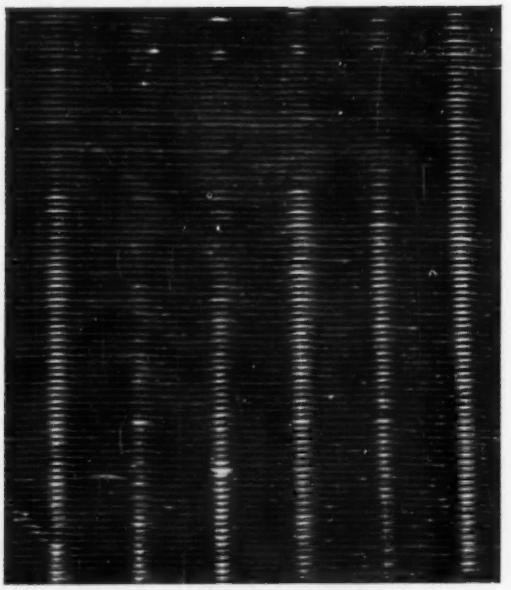
Bonderite 710 and 720 solutions are sludgeless, easily controlled, uniform in results.

These treatments may be used to increase the durability of paint finishes with equally outstanding effectiveness.

The Parker man in your territory has valuable experience to share with you in treating aluminum and its alloys. A letter or phone call will bring him to you.



UNTREATED—Unretouched photo of section of aluminum heat exchanger after 1150 hours in salt spray. Note corrosion.



BONDERITE-TREATED—Unretouched photo of section of identical aluminum heat exchanger after 1150 hours in salt spray. Note absence of corrosion.

SINCE 1914—LEADER IN THE FIELD

PROTECTED BY Bonderite PARKER RUST PROOF CO. QUALITY CORROSION RESISTANT

PARKER RUST PROOF COMPANY
2181 E. MILWAUKEE, DETROIT 11, MICHIGAN

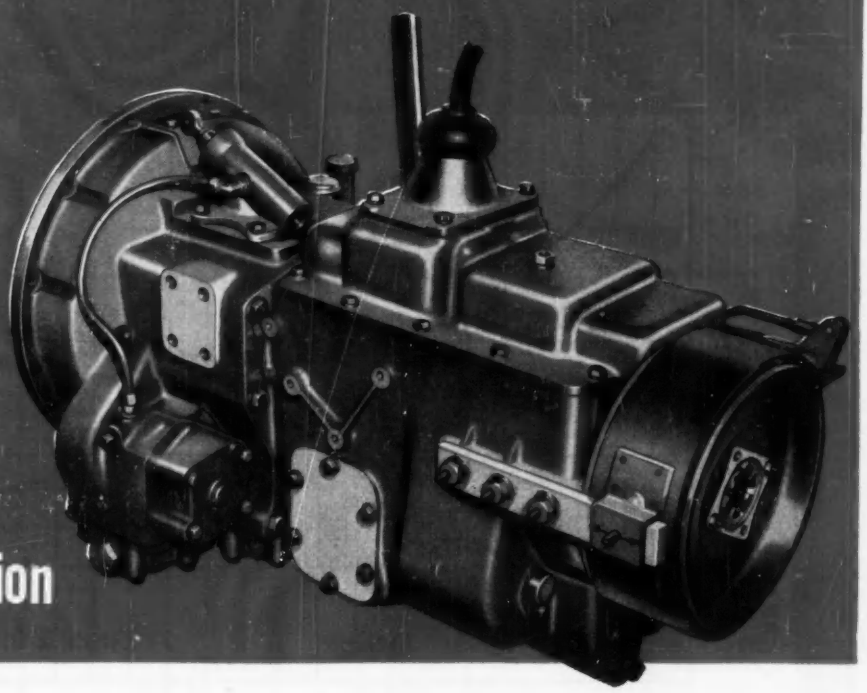
BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883

NEW !

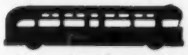
the CLARK TransVerter

COMPACT
UNIT
"PACKAGE"
OF

* Torque Converter
* Hydraulic Clutch
* Transmission



Trucks Operating on delivery schedules



Coaches making frequent stops

Garbage and trash collection

Concrete mixers and similar industrial applications

Materials handling machinery

Many stationary power plants and oil field applications

CLARK EQUIPMENT

Now comes more profitable performance for the operators of stop-and-go vehicles—trucks, both highway and off-the-highway, garbage and trash collectors, concrete mixers, materials handling machines and others: smoother, more economical handling made possible by Clark's new TransVerter.

- **No heavy clutching—reduces driver fatigue. Easy control of hydraulic clutch by shift lever button, floor button, or light pressure clutch pedal**
- **Fine inching control with accelerator**
- **Gear shifting reduced appreciably. Gear changes made quicker**
- **Closely spaced ratios add to ease of shifting resulting in added transmission life**
- **Starts smoothly, no stalling, no lugging**
- **Longer life for entire drive-train—no shock-loading**
- **Less wheel slip—Tires last longer**
- **Clutch adjustment eliminated—Result: savings on costly down time**
- **Excellent accessibility for easy service. Serviceable without special tools by any mechanic familiar with transmissions**
- **Available for OEM or field conversion**

Get the interesting story of these advantages whose economies far offset the moderate additional cost. Send for bulletin.

CLARK EQUIPMENT COMPANY, Transmission Division, Falahee Road, Jackson 5, Michigan
Please send the TransVerter Bulletin

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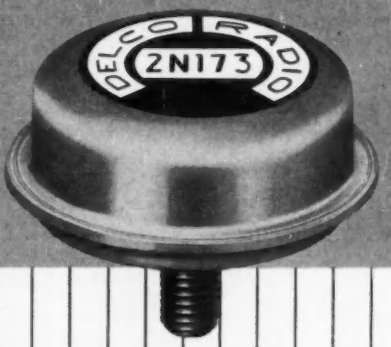
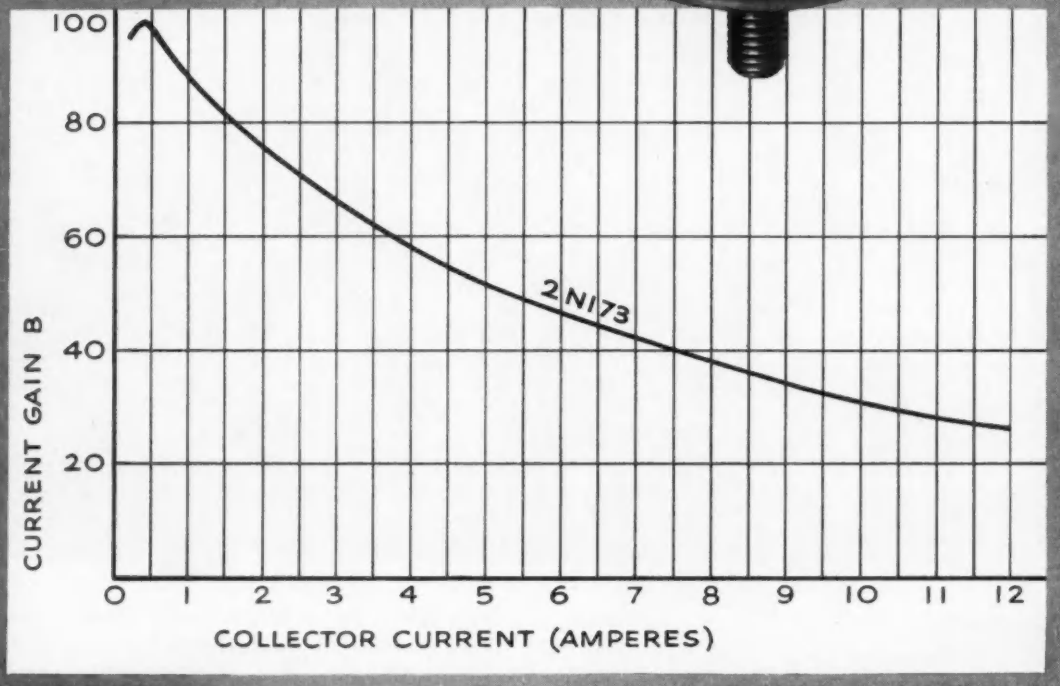
Industry's Highest Power Transistors





Delco Radio "High-Power" Transistors set a new industry standard of performance—

Produced by the thousands each day!

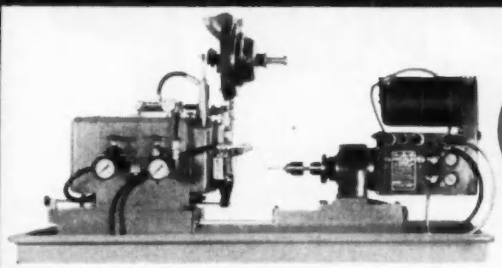
Delco Radio alloy junction germanium PNP power transistors 2N173 and 2N174, now in volume production, are characterized by high output power, high gain and low distortion. Stabilizing processes eliminate the effect of time on performance characteristics.

The high power handling ability does not exclude applications for low and medium power levels. Performance at low levels exceeds that of many low power transistors and will provide a higher degree of safety and stability to equipment design.

TYPICAL CHARACTERISTICS			
	2N173	2N174	
Properties (25°C)	12 Volts	28 Volts	
Maximum current	12	12	amps
Maximum collector voltage	60	80	volts
Saturation voltage (12 amp.)	0.7	0.7	volts
Power gain (Class A, 10 watts)	38	38	db
Alpha cutoff frequency	0.4	0.4	Mc
Power dissipation	55	55	watts
Thermal gradient from junction to mounting base	1.2°	1.2°	°C/watt
Distortion (Class A, 10 watts)	5%	5%	

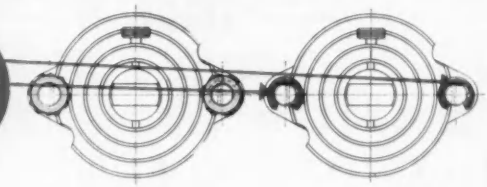
DELCO RADIO DIVISION OF GENERAL MOTORS
KOKOMO, INDIANA

Waldes Truarc Retaining Rings Eliminate Machining and Parts—Cut Assembly Time on Drill and Tapper



Beco Model 410 Drill and Tapper

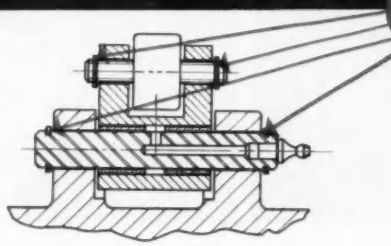
The Batchelder Engineering Co., Inc., Springfield, Vermont uses 4 different sizes of 2 different type Waldes Truarc rings in their new BECO Model 410 Automatic Drill and Tapper. Truarc rings speed assembly, reduce machining, improve design.



ALTERNATE DESIGN TRUARC DESIGN

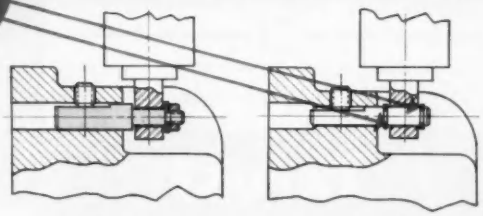
Clamp Cylinder Rod Stop Assembly

Truarc "E" Rings (Series 5133) replace stop nuts in the Clamp Cylinder assembly. They eliminate need for threading 2 rods ...the danger of cross-threading nuts...and costly rejects. Truarc Rings cut assembly time and cost.



Bell Crank Pivot Assembly

Truarc Rings (Series 5100) in Bell Crank Pivot assembly permit grease hole not possible with cotter pin fastener. Use of nuts would have increased machining and assembly costs considerably.



ALTERNATE DESIGN TRUARC DESIGN

Hopper Cylinder Anchor Pin Assembly

2 Truarc Rings (Series 5100) secure and position end of vertical air cylinder. Rings eliminate extra cost of machining 3-diameter pin, threading and undercutting... plus nut and washer. Assembly is quick and sure.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name .....
Title .....
Company .....
Business Address .....
City ..... Zone ... State .....

SA12

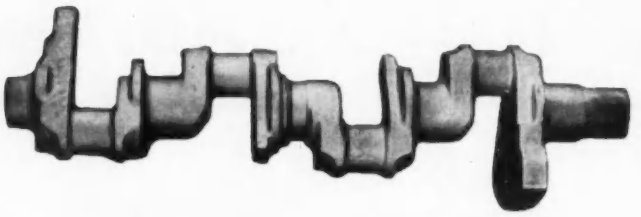
WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

whether you think in terms of

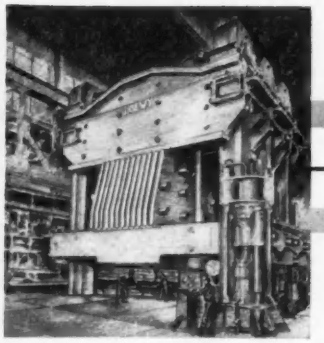
Horsepower

— or —

Thrust

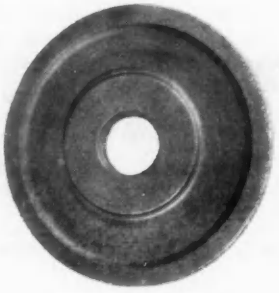


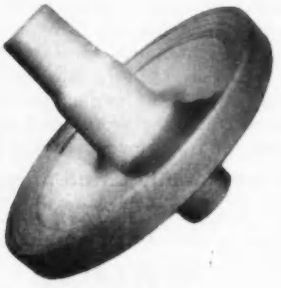
The crankshaft is the backbone of the piston-type engine. Illustrated above is the crankshaft forging for the most powerful piston-type aircraft engine ever produced.



The history of Wyman-Gordon's contribution to aircraft progress dates from the inception of the "flying machine". The jet age is now calling on the unparalleled resources of Wyman-Gordon, which include the widest range of hammer and press equipment and the greatest technical know-how in the industry. Larger and more intricate forgings than heretofore available of aluminum and magnesium are being produced on presses up to 50,000 ton capacity, and giant hammers are fulfilling the growing need for forgings of titanium, high density materials or so-called super alloys. Now, as for nearly 75 years, there is no substitute for Wyman-Gordon experience and ability for — Keeping Ahead of Progress.

At the bottom left is a turbine disc forging made from high density heat resisting alloy, and next to it is a titanium compressor wheel forging for two of the most powerful jet engines yet produced.





WYMAN-GORDON COMPANY

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS

HARVEY, ILLINOIS • DETROIT, MICHIGAN

NEW

VICKERS®

Miniaturized

PISTON TYPE HYDRAULIC PUMPS

3000 psi . . . CONSTANT DISPLACEMENT

These new miniaturized hydraulic pumps were developed by Vickers for limited life applications such as missile and ram air turbine driven hydraulic systems . . . also for motorpump assemblies supplying emergency power on aircraft.

A distinctive feature is adaptability to manifolding and special mounting. This permits integration with the balance of a "packaged" hydraulic system to provide hydraulic power in the most compact and lightweight form yet devised. Some sizes are capable of delivering more than five horsepower per pound of weight.

Available in four size series, this miniaturized pump has the same basic characteristics as the standard Vickers piston type pump which has been establishing outstanding performance records on aircraft since 1940. Ask nearest Vickers Aircraft Application Engineer for further information.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

ADMINISTRATIVE and ENGINEERING CENTER
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El Segundo Division • Engineering, Sales and Service
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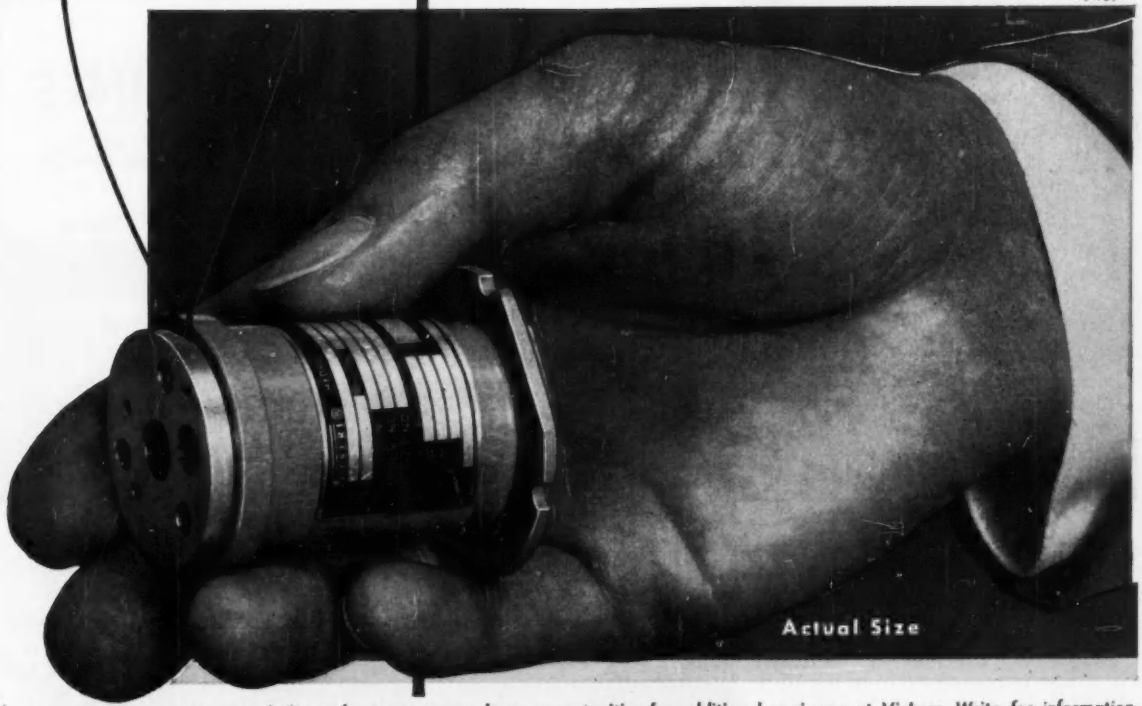
TELEGRAMS: Vickers WUX Detroit • TELETYPE "ROY" 1149
CABLE: Videt
OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd. Great West Road, Brentford, Middx., England

Engineers and Builders of Oil Hydraulic Equipment Since 1921

This Hydraulic Pump has 4.3 hp output @ 3000 psi and 12,000 rpm. Weight 0.9 lb.

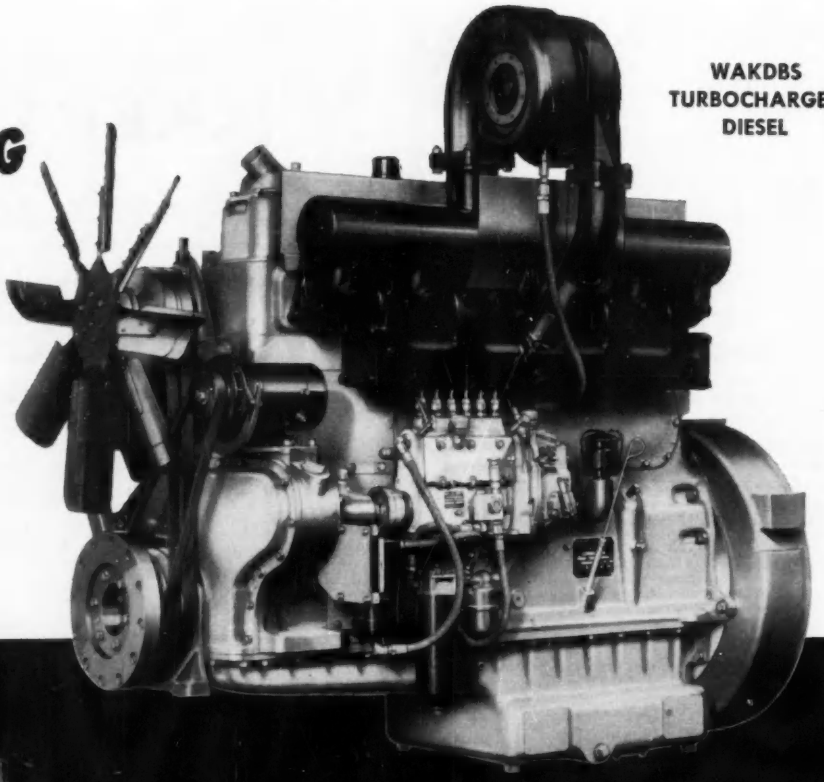
7469

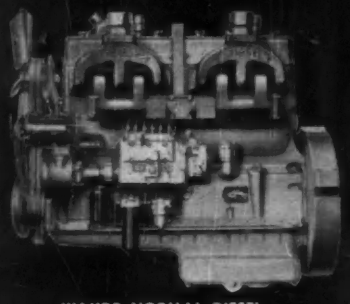


A large expansion program now in its early stages means large opportunities for additional engineers at Vickers. Write for information.

FOR HEAVY HAULING

WAKDBS TURBOCHARGED DIESEL





WAKDB NORMAL DIESEL

WAKR BUTANE

WAUKESHA

1197 CUBIC INCH

Extra Heavy Duty ENGINES

Up to 352 max. hp, *all with counterbalanced crankshafts*

Write for descriptive bulletins

Truck powered by Waukesha WAKR (Butane)

327

WAUKESHA MOTOR COMPANY

Waukesha, Wisconsin

New York Tulsa Los Angeles

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Latest member of the N-A-X family of High-Strength Steels

COMPANION HIGH-STRENGTH STEELS TO N-A-X FINEGRAIN

N-A-X HIGH-TENSILE STEEL

A low-alloy, high-strength steel possessing all of the characteristics of N-A-X FINEGRAIN plus enhanced resistance to atmospheric corrosion.

N-A-XTRA HIGH-STRENGTH STEEL

Heat-treated alloy plates of weldable quality having yield strengths of 70,000 psi upwards.

N-A-X FINEGRAIN is a low-alloy, high-strength steel with many diversified applications in modern metals design. Compared with carbon steel—

- **It is 50% stronger.**
- **It has high fatigue life with great toughness.**
- **It has greater resistance to wear or abrasion.**
- **It is readily welded by any process.**
- **It is stable against aging.**
- **It polishes to a high luster at minimum cost.**
- **It can be cold formed readily into the most difficult stampings.**

With N-A-X FINEGRAIN you can design lighter weight, longer life and economy into your products. Let us show you how.

N-A-X Alloy Division
GREAT LAKES STEEL CORPORATION
Detroit 29, Michigan • A Unit of
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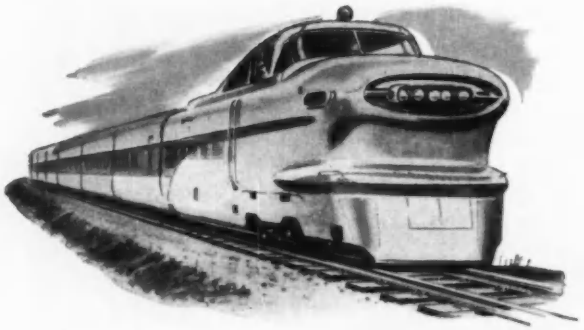
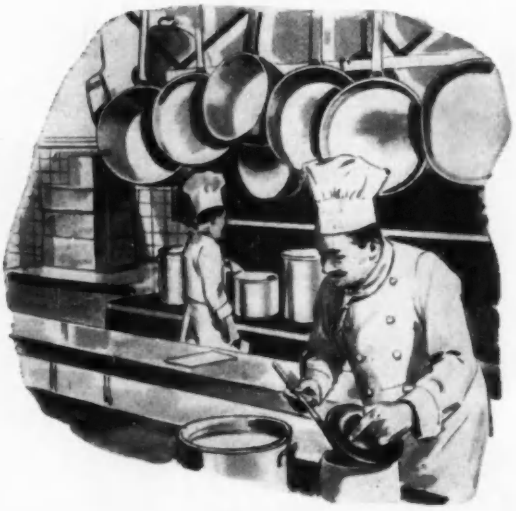
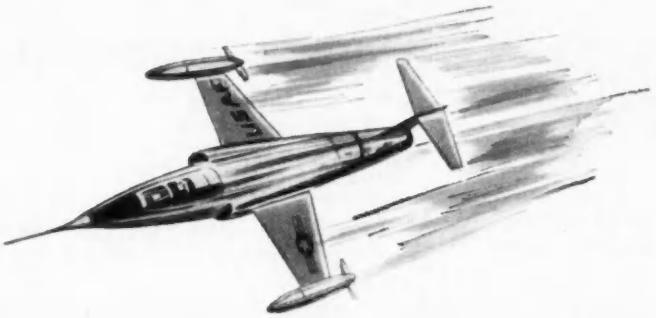
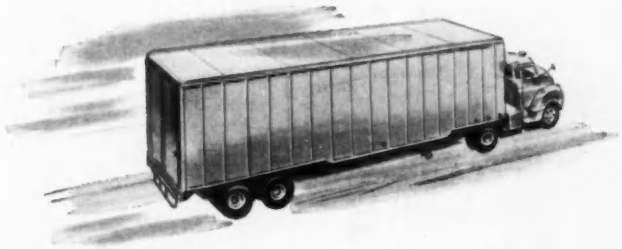
Now... You can make more things of









Stainless Steel

The new "200" Series Stainless Steels successfully ease nickel shortage!

With the new low-nickel "200" Series Stainless Steels, producers can greatly expand their output of Chrome-Nickel stainless from existing nickel supplies. These steels provide practical, workable grades of stainless that can be applied to a wide variety of uses.

Made of Chromium-Nickel-Manganese—the "200" Series steels are helping to meet constantly growing needs in transportation, building, manufacturing and many other fields. They're becoming increasingly popular in kitchen utensils, appliances, truck bodies, trains, automobile trim, and scores of products for industrial, home and business use. For further information, see your stainless steel supplier, or write Electromet—leading producer of more than 100 alloys, including chromium and manganese, for the steel and non-ferrous metal industries.

ELECTRO METALLURGICAL COMPANY

A Division of Union Carbide and Carbon Corporation

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The term "Electromet" is a registered trade-mark of Union Carbide and Carbon Corporation

Electromet

Metals do more all the time . . . Thanks to Alloys

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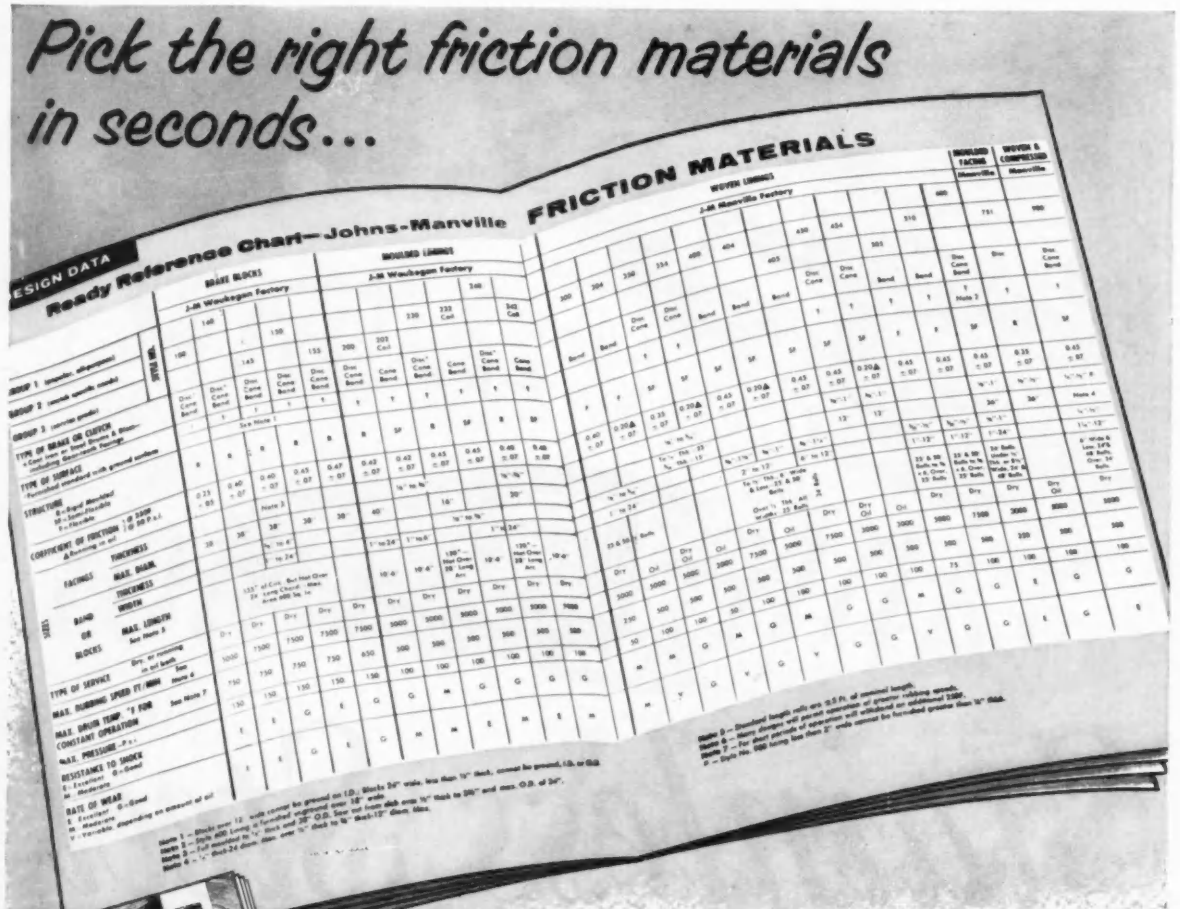
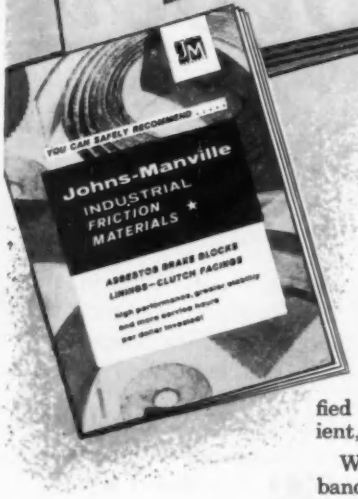
Pick the right friction materials in seconds...





It's in Johns-Manville's handy new Friction Materials Selector

When you encounter a design problem that involves the control of motion, you'll find this new, ready-reference book about Johns-Manville Friction Materials a big help. Its sixteen pages are loaded with specific design data, presented in simplified table form, that you'll find convenient, accurate and easy to use.

Whether you require a disc, cone, band, block or lining—for application in wet or dry service, heavy or light duty, slow or high speed operation, light or heavy pressure—this book will give you performance characteristics, available sizes and shapes, dimension data and tolerances.

Whatever your problem dealing with the control of motion the J-M Friction Material specialist . . . backed by unmatched J-M Research facilities . . . is at your service. Write Johns-Manville, Box 14, New York 16, N.Y., for your free copy of the Friction Materials Guide—FM35A. *In Canada, Port Credit, Ont.*

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Johns-Manville *Industrial* FRICTION MATERIALS

PRODUCT PERFORMANCE

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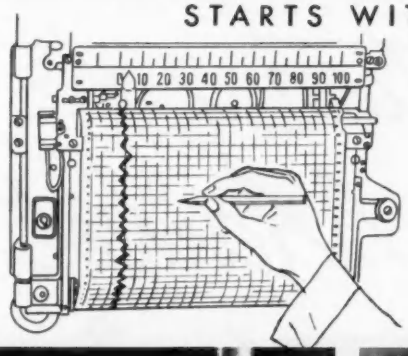
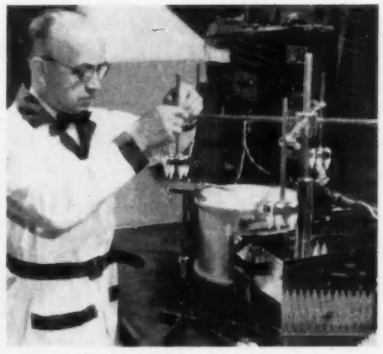


RESEARCH: Pictured below are several research operations manned by a creative staff of skilled technicians who constantly work to improve AC Spark Plug performance.

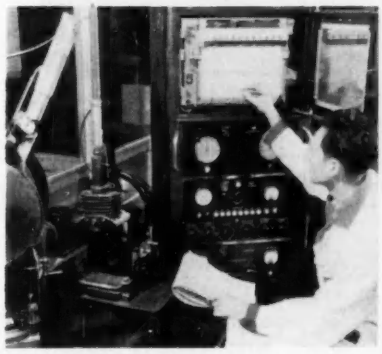
Basic research in the areas of spark plug insulator strength, density, thermal shock resistance and electrical resistance might take months or years to evaluate under actual operating conditions. With these research tools, it can often be completed in a matter of days.

ELECTRON MICROSCOPE. Shapes and sizes of the crystals in spark plug insulator materials and the way in which these crystals bond together are photographed and studied by means of this powerful electron microscope in the hands of carefully trained observers.

PETROGRAPHIC MICROSCOPE. This microscope in the hands of an experienced "detective" can reveal the processing history of insulator material. This provides valuable clues as to why one experimental insulator has better operating characteristics than another.

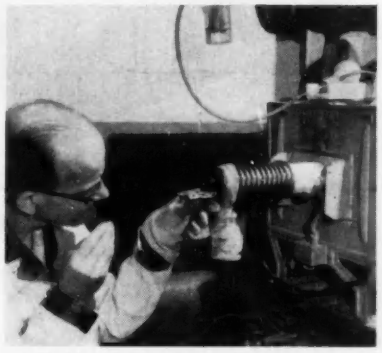


THERMAL SHOCK. The fracture point of experimental insulators is quickly revealed when insulators are dipped in molten metal. Fractures show up plainly when insulators are dipped in fluorescent oil, wiped clean and then viewed under ultraviolet light.



X-RAY DIFFRACTOMETER. This device is used to reveal the identity of chemical compounds which deposit on spark plug insulators. Experimental insulators with an unusual affinity for combustion deposits or unusual resistance to same are quickly discovered.

THERMAL CONDUCTIVITY MACHINE. How much heat? How fast does it travel? Heat and the speed with which it goes from here to there are measured by this machine . . . giving valuable clues to the thermal conductivity of various insulator tip designs.



CORROSION-RESISTANT FURNACE. Which electrode alloys resist combustion fouling to the greatest degree? Tests equivalent to 10,000 miles of actual driving can be done in an hour (plus or minus a few minutes) and without putting a single driver behind the wheel.

RESULT: spark plugs that have proved themselves in the laboratory long before they are ever subjected to operational testing.

Call on the outstanding facilities of AC — creative research, design and manufacturing — to help insure top engine performance even under the most extreme conditions.

AC

AC SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS

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QUALITY PRODUCTS

LOOKS LIKE Pontiac Cornered the Market ON "FIRSTS"

It's new from power to personality, this '57 Pontiac, and packed with a carload of fresh ideas that caught the entire industry by surprise! There are over 6-dozen "firsts" in this spanking-new beauty, all proved and polished to perfection in the most grueling road test ever undertaken—the 100,000-mile Marathon Run! Sample the '57 Pontiac's cloud-soft ride, its cat-quick wheel response, the lusty brilliance of its all-new V-8 engine. This solidly proved newcomer will spoil you for anything else!

FIRST CAR AT ANY PRICE WITH . . .

Star Flight Body Design—*a Pontiac Exclusive—longer and lower than ever before—'57's most distinctive automotive styling.*

The "Off-the-Shoulder" Look Interior Styling—*a fashion "first" for '57—perfectly color-matched with the exterior of your choice.*

New Strato-Streak V-8 Engine—*270 h.p. in the Star Chief and Super Chief Series, 252 in the Chieftain—with smoother Strato-Flight Hydra-Matic, an extra-cost option.*

Cloud-soft, Level-Line Ride—*the ride sensation of the year—a new suspension system based on a big, road-hugging 124- or 122-inch wheelbase.*

Three Popular-Priced Series: *Star Chief • Super Chief • Chieftain.*

PONTIAC MOTOR DIVISION • GENERAL MOTORS CORPORATION

IT'S AMERICA'S NUMBER (1) ROAD CAR!

SPECTOR...Chicago's largest... standardizes on Fuller ROADRANGERS®

Spector Freight Systems, Inc., largest common carrier with home offices in Chicago, is adding 104 new tractors equipped with R-46 ROADRANGERS to bring a total of 257 ROADRANGER equipped tractors to its fleet.

Referring to Spector's 149 tractors now equipped with Fuller 8-speed ROADRANGERS, to 4 tractors equipped with 10-speed ROADRANGERS . . . and to the 104 new units with 8-speed Model R-46 ROADRANGERS, C. L. Lunt, Vice President, Operations, says:

"We have standardized on the ROADRANGER Transmission for better over-all fleet performance and less maintenance . . . resulting, of course, in a substantial dollar savings. Also, our drivers overwhelmingly prefer the semi-automatic Fuller ROADRANGER Transmission."

C. L. Lunt, Vice President, Operations

Spector, whose gross revenues rose from $1½-million in 1945 to an estimated $21-million in 1955, *knows* the value of better over-all fleet performance. Spector drivers prefer ROADRANGER 8 and 10-speed Semi-Automatic Transmissions with:

- **Easier, quicker shifts—all forward speeds in short closely spaced steps between ratios**
- **One shift lever that controls all forward speeds**
- **No gear splitting—all selective gear ratios are evenly and progressively spaced**
- **Higher average road speeds—engines operate in peak hp range with greater fuel economy**
- **Less driver fatigue—⅓ less shifting**
- **Range shifts pre-selected—automatic and synchronized**

• • •

Compact space-and-weight-saving economies permit more cargo to be carried on payload axles. Get full facts on ROADRANGER from your truck manufacturer or truck dealer, now!

FULLER MANUFACTURING COMPANY
TRANSMISSION DIVISION • KALAMAZOO, MICH.

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

For Push-Pull Rod Assemblies

HEIM
Unibal ROD ENDS

The common function of all push-pull rod assemblies is the transmission of force and motion from one machine component to another.

For their ease of assembly, smooth operation, comparatively low cost, as well as ability to correct misalignment, choose Heim Unibal Rod Ends.

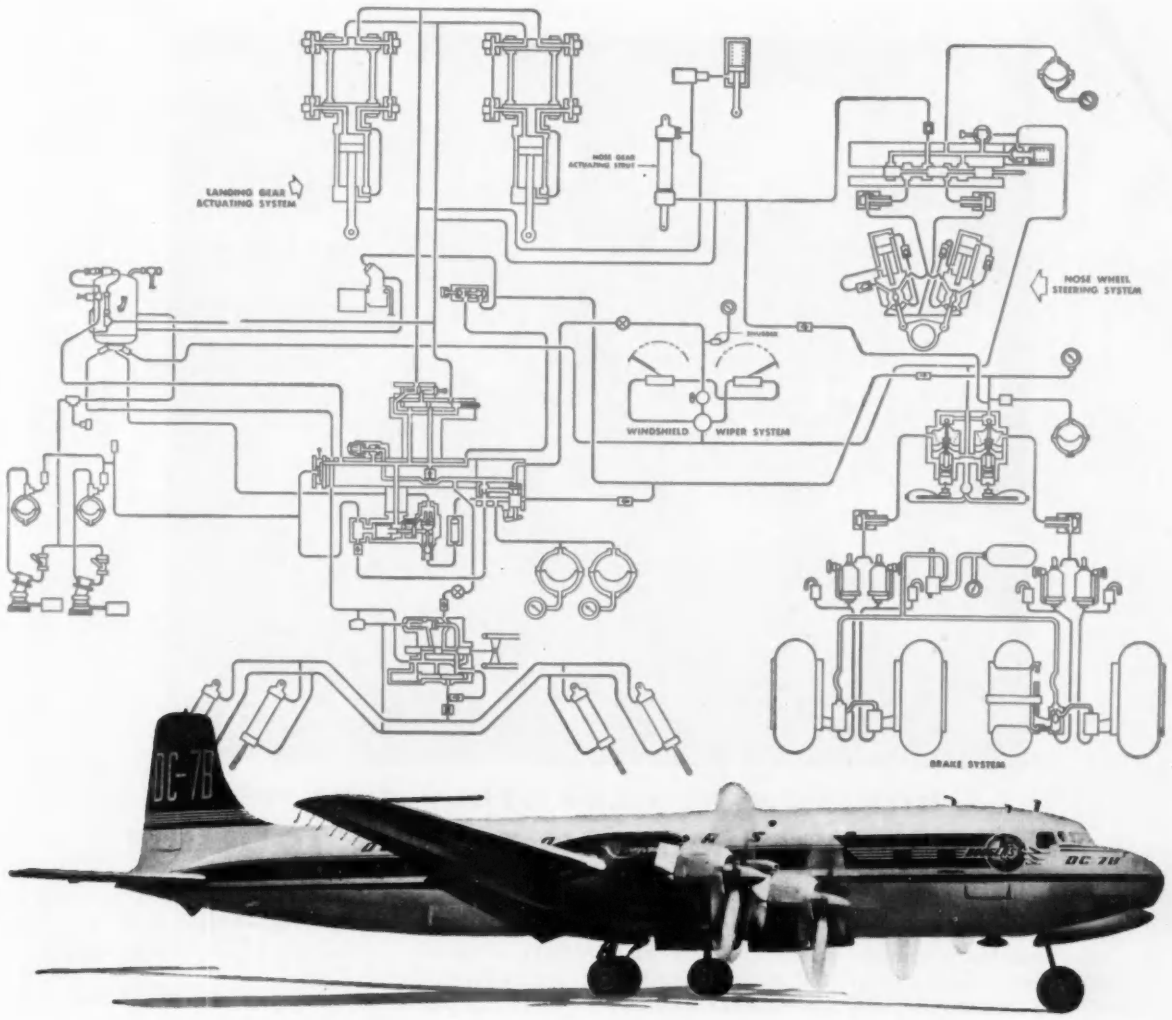
In the operation of the Sweater-Looper, made in Philadelphia by John W. Hepworth & Co., there is a horizontal drive rod, a vertical drive rod, and a needle drive rod. At both ends of each drive rod are Heim Unibal Rod Ends — for smooth, trouble-free, continuous production.

The Hepworth Sweater-Looper is used for all types of sweater collars, sleeves, and shoulders. Collars can be set on a completely assembled knitted garment in a single continuous operation. Heim Unibal Rod Ends perform so well on the sweater-looper that Hepworth has redesigned their hosiery-looper to include Heim Rod Ends in the linkage assemblies.

Write for complete catalog, or for any engineering advice.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT



Enjay Butyl rubber— vital artery in newest airliners

Douglas chooses Enjay Butyl for rubber components of the hydraulic systems in many of its famous DC-7 airliners. These components, which help assure the dependable operation of everything from wing flaps to landing gear, are proving over millions of air miles their durability and resistance to wear.

Versatile Enjay Butyl rubber may well have a place in *your* operation. It will pay you to investigate the many technical advantages it has over other types of rubber. Its price and ready availability are advantages, too. For full information, and for technical assistance in the uses of Enjay Butyl, contact the Enjay Company today.

ENJAY BUTYL

ENJAY *Pioneer in Petrochemicals*

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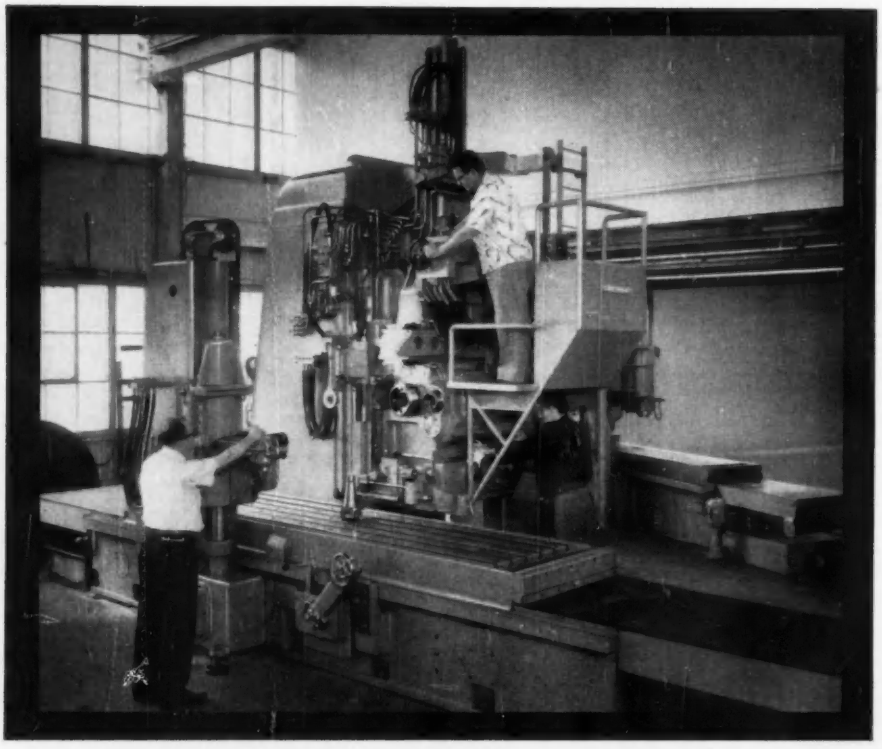
Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

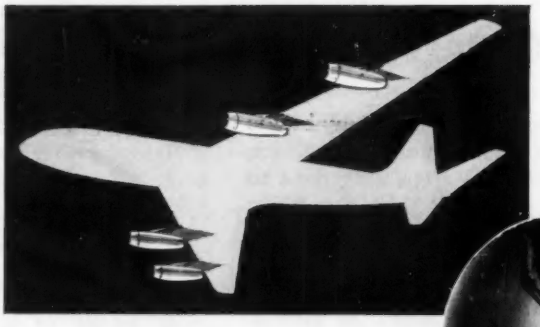


HORIZONTAL HYDROTEL – PART OF
ROHR'S MULTI-MILLION DOLLAR TOOL KIT

This 36" x 120" Cincinnati Horizontal Hydrotel shown above employs three different tracers, a 360-degree tracer, a depth control tracer for contour milling, and a rise and fall tracer. It assures extreme accuracy for very special Rohr jobs.

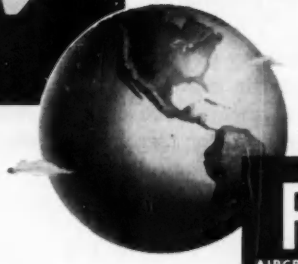
With this and hundreds of other heavy, modern manufacturing machines, Rohr produces over 30,000 different aircraft parts for builders of many of America's leading commercial and military planes. This is, of course, in addition to Rohr's fame as the world's largest producer of ready-to-install Power Packages.

For full production facilities – for design and engineering know-how, look to Rohr to build more into the aircraft parts you need.



In addition to the Boeing 707 Rohr builds Power Packages for many other commercial and military planes which have made Rohr famous as the

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES



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AIRCRAFT CORPORATION

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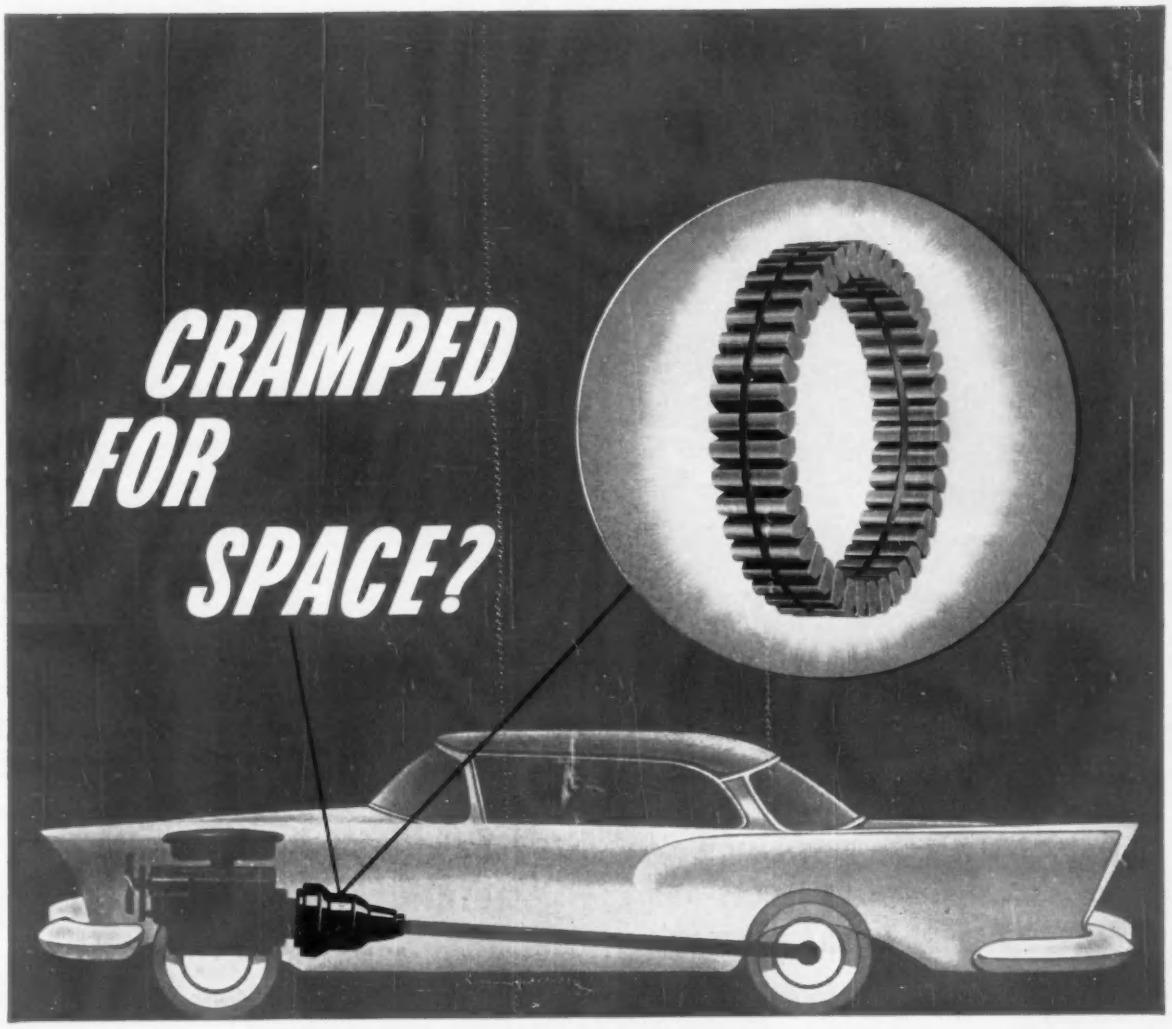
Plants in Chula Vista and Riverside, California; Winder, Georgia; Auburn, Washington



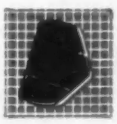
Artificial spacing is eliminated with Formsprag full-complement over-running clutches

Many sprag-type, over-running clutches demand *artificial* spacing to assure immediate engaging and consistent release of sprags.

Formsprag has eliminated it! Here's how. Exclusive, highly-developed "D-shaped" sprags automatically space themselves—they engage and release accurately time-after-time. What does this mean in terms of space saving? This patented sprag principle —used widely in automotive and aircraft applications—permits Formsprag to insert a *full complement* of sprags in far less space. Full-complement construction gives you more sprag contact for *any* space you allocate for an over-running clutch—therefore more engine torque is transmitted. And you have the advantage of Formsprag's precision manufacturing and design facilities to supply *complete* clutches which complement your design. Another advantage: Formsprag's simple, basic design makes prototypes economical for testing purposes.

The next time the question of being "cramped for space" arises, call on Formsprag—World's largest exclusive manufacturer of over-running clutches.

FORMSPRAG COMPANY



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THE ONLY CLUTCH THAT CAN GIVE YOU FULL-COMPLEMENT PERFORMANCE

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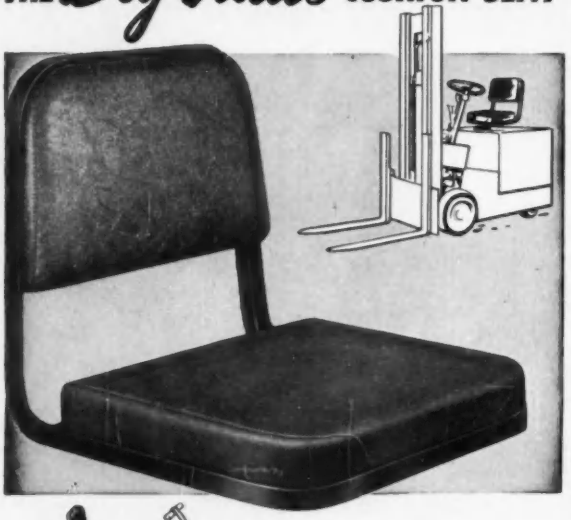
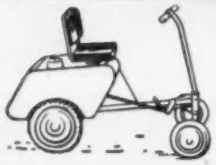
Thrift-King

THE Big Value CUSHION SEAT





For POWER MOWERS, LIFT TRUCKS AND OTHER MEDIUM MOBILE EQUIPMENT

"Thrift-King" is a 2-way value seat for manufacturers of lift-trucks, mowers, and many types of medium mobile equipment: it definitely adds "sell;" it definitely improves workability. Full cushion foam rubber seat and full cushion foam rubber back rest assure sustained comfort and operational freedom. Wide choice of covering materials that will withstand outdoor use. Frame is of solid one-piece welded construction for rigorous service; easily attached. Available as illustrated, or with special features engineered to your equipment.

Write for complete information on America's finest line of cushion seating — Milsco.

MADE TO FIT YOUR NEEDS

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Imperial

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metallurgist

special position
solving
special problems
in

HIGH TEMPERATURE METALLURGY

The very latest materials must be used to enable the gas turbines produced by the Small Aircraft Engine Department of General Electric to withstand the stresses of extremes in temperature while keeping a power-weight ratio of more than 4 to 1.

Essential to participation in this advanced program of applied research is the knowledge of high temperature metallurgy, metallurgical laboratory and experimental techniques, including testing, procedures and equipment.

Right now, there are openings which involve:

- **Searching out the latest materials, investigating and testing them to determine fitness to most particular requirements.**
- **Developing experimentally new metals or metallurgical processes.**
- **Evaluating metallurgical failures in engines or engine components.**

These positions are unusual in more ways than just the nature of the work involved: advancement is rapid, and benefits extraordinary. And you'll enjoy living near Boston, cultural center for all New England.

Write in strict confidence to:
Mr. T. S. Woerz (Section R-A-5)
Small Aircraft Engine Dept.

GENERAL ELECTRIC
1000 Western Avenue, West Lynn, Mass.

The C-123 can't stop on a dime—

but it can land in 700 feet!

FAIRCHILD

AIRCRAFT DIVISION • HAGERSTOWN 10, MARYLAND

A Division of Fairchild Engine and Airplane Corporation

...WHERE THE FUTURE IS MEASURED IN LIGHT-YEARS!

Meet the most agile, the most sure-footed transport in the world – the Fairchild C-123. It is capable of air-lifting up to 60 troops, or up to eight tons of bulk combat cargo—and it needs no mile-long concrete runway.

Almost any clearing, almost any field is a potential C-123 airbase; even deeply rutted, ungraded, or sandy grounds are taken in stride by this rugged ship. And sophisticated aerodynamic design makes possible a landing run of only 700 feet—a takeoff run only a little longer.

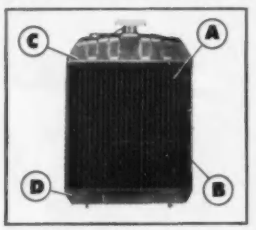
Performance, ruggedness, payload and versatility . . . these are traditional hallmarks of Fairchild aircraft.

Young Engineering Talent Pays off for SAFE-WAY*

*Safe-Way School Bus, built by Marmon-Herrington Co., Inc., Indianapolis, Ind.

Young Side-Mounted Radiators keep 182-hp. bus engines cool

The Problem: To select an engine-cooling radiator built for easy accessibility and efficient upkeep.



Young Stamped Tank Sheet Metal Radiator

How Young solved it

Young Radiator Company built a pressurized, heavy-duty fin type unit with a compact, 625-square-inch frontal area. This Young Radiator was side-mounted at rear of bus for convenience and safety. It cools a heavy duty 332-cu.-in. overhead valve V-8 engine developing 182 hp at governed engine speed.

A. Fully-soldered, double lock-seam tubes.

B. Full wrap-around, terne plate side members.

C. Double-grip 2-way headers.

D. Capacities to 300,000 btu/hr.

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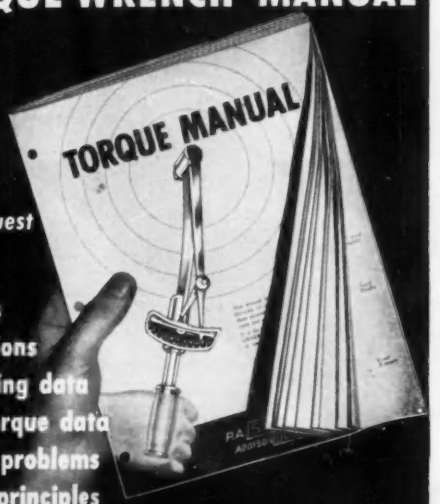

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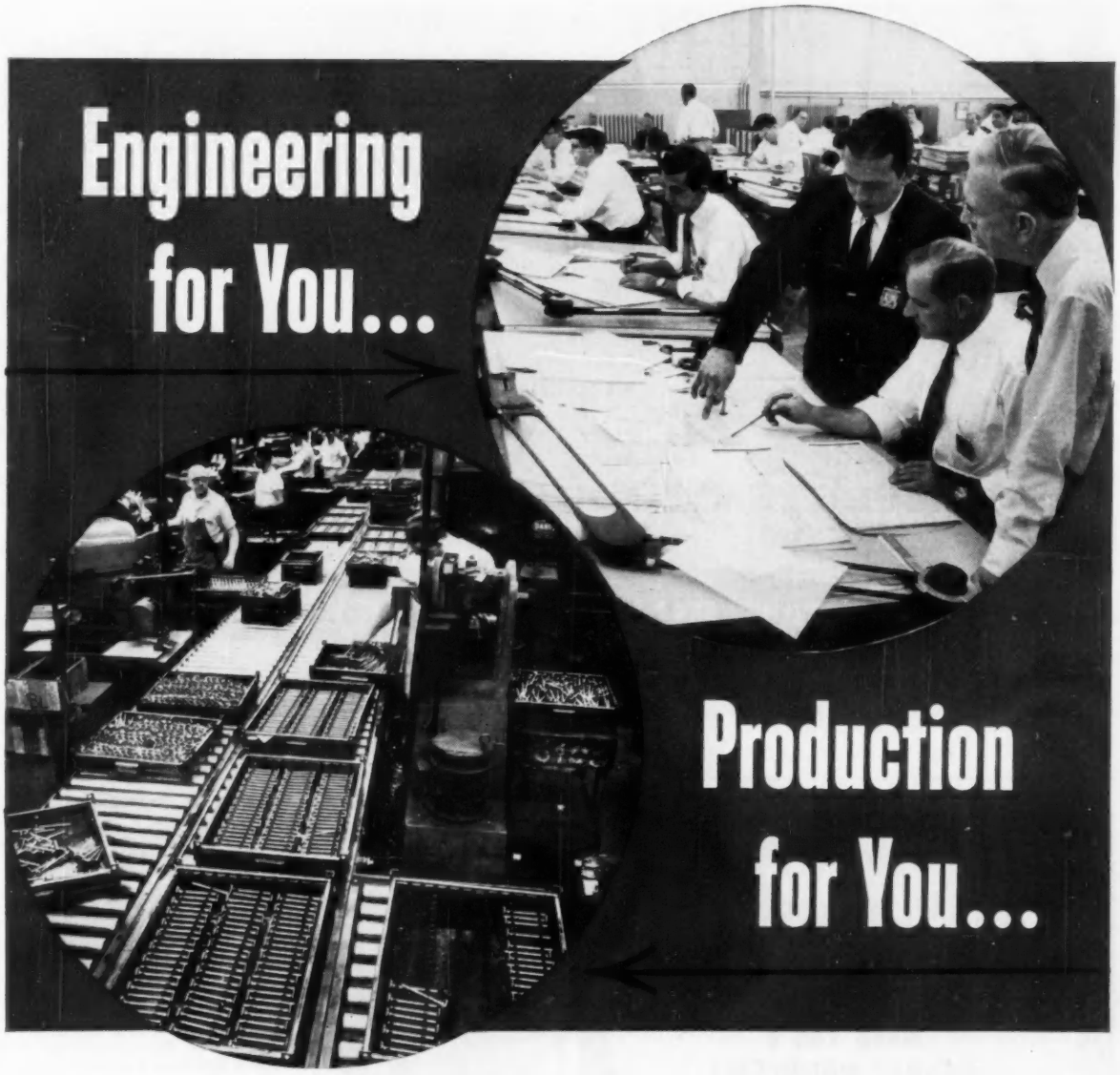

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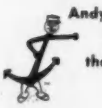

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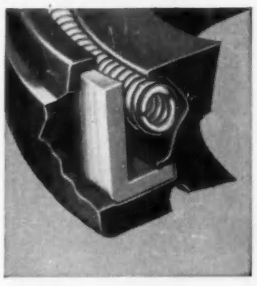

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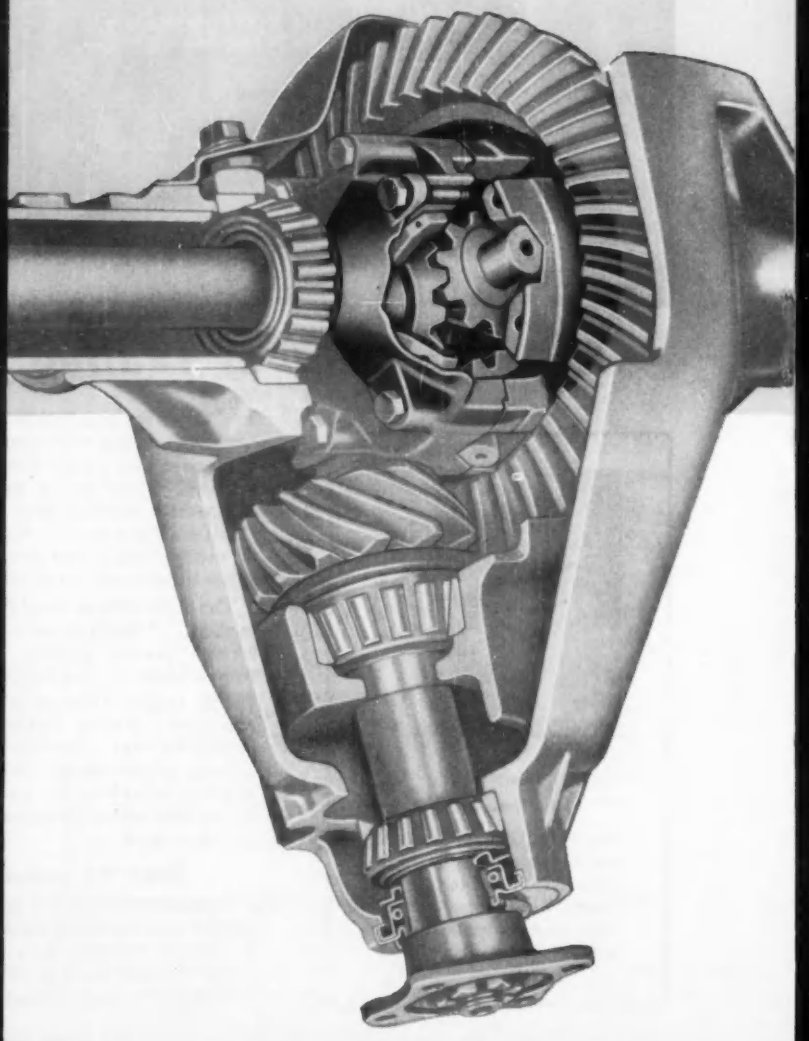

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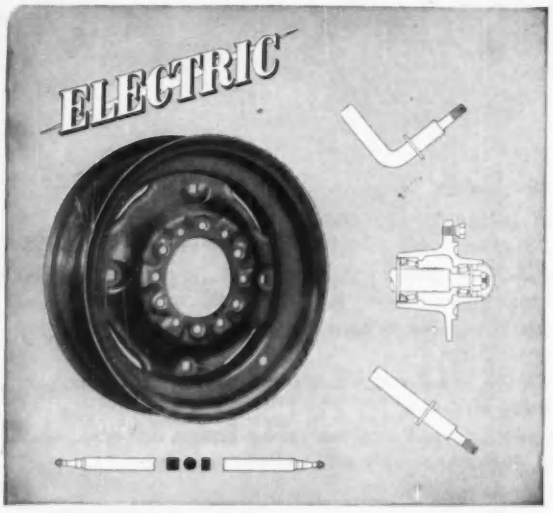

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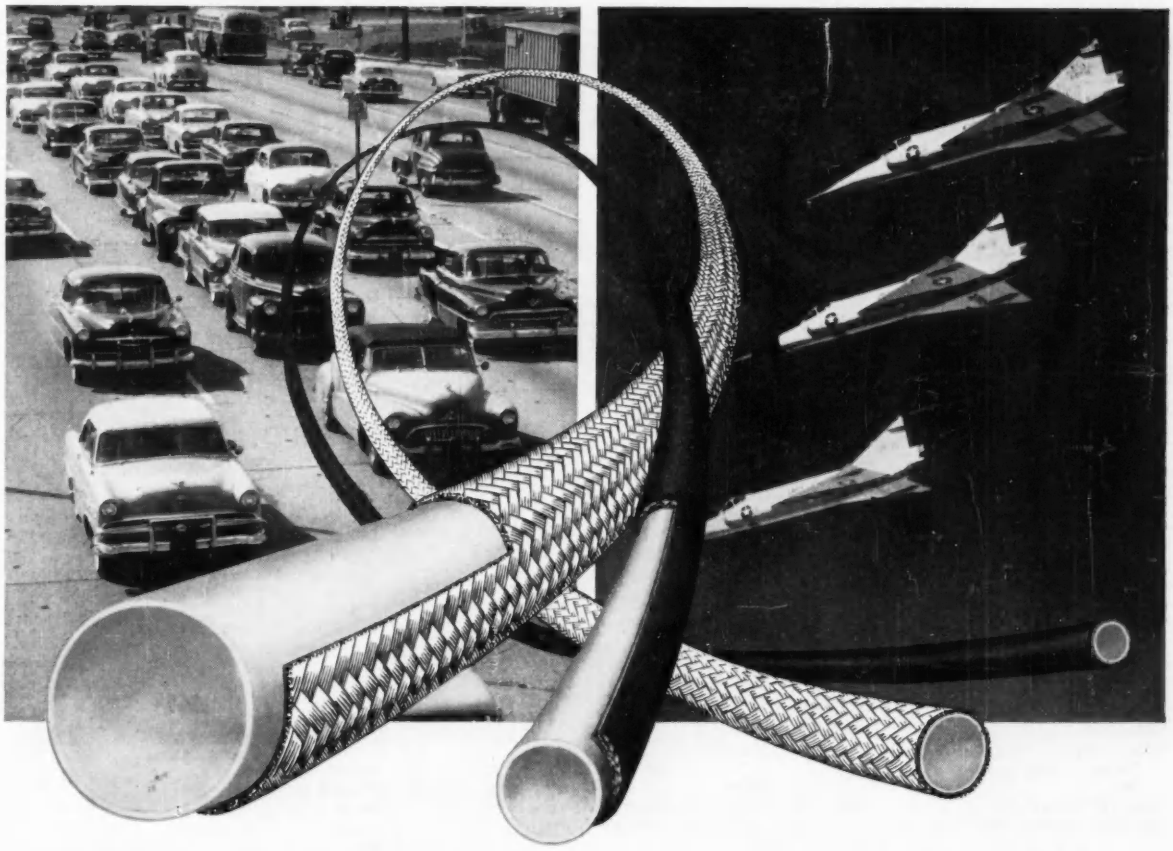

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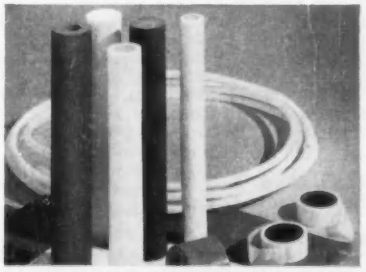

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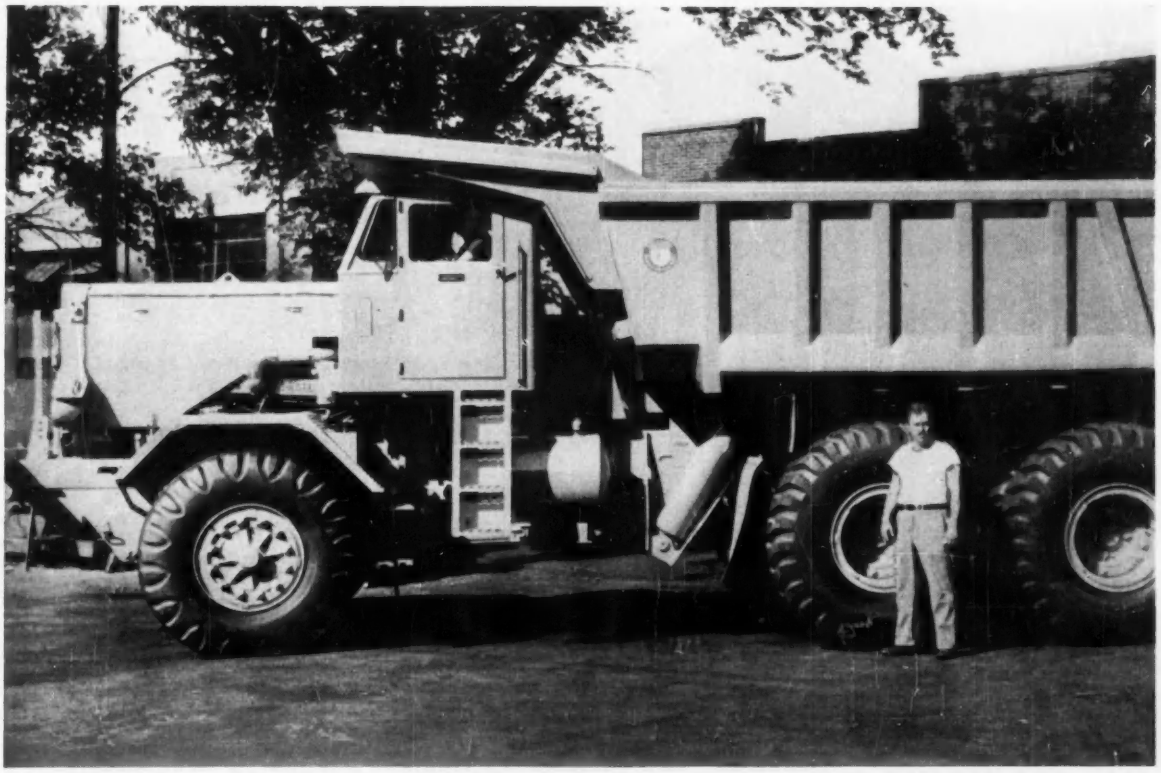

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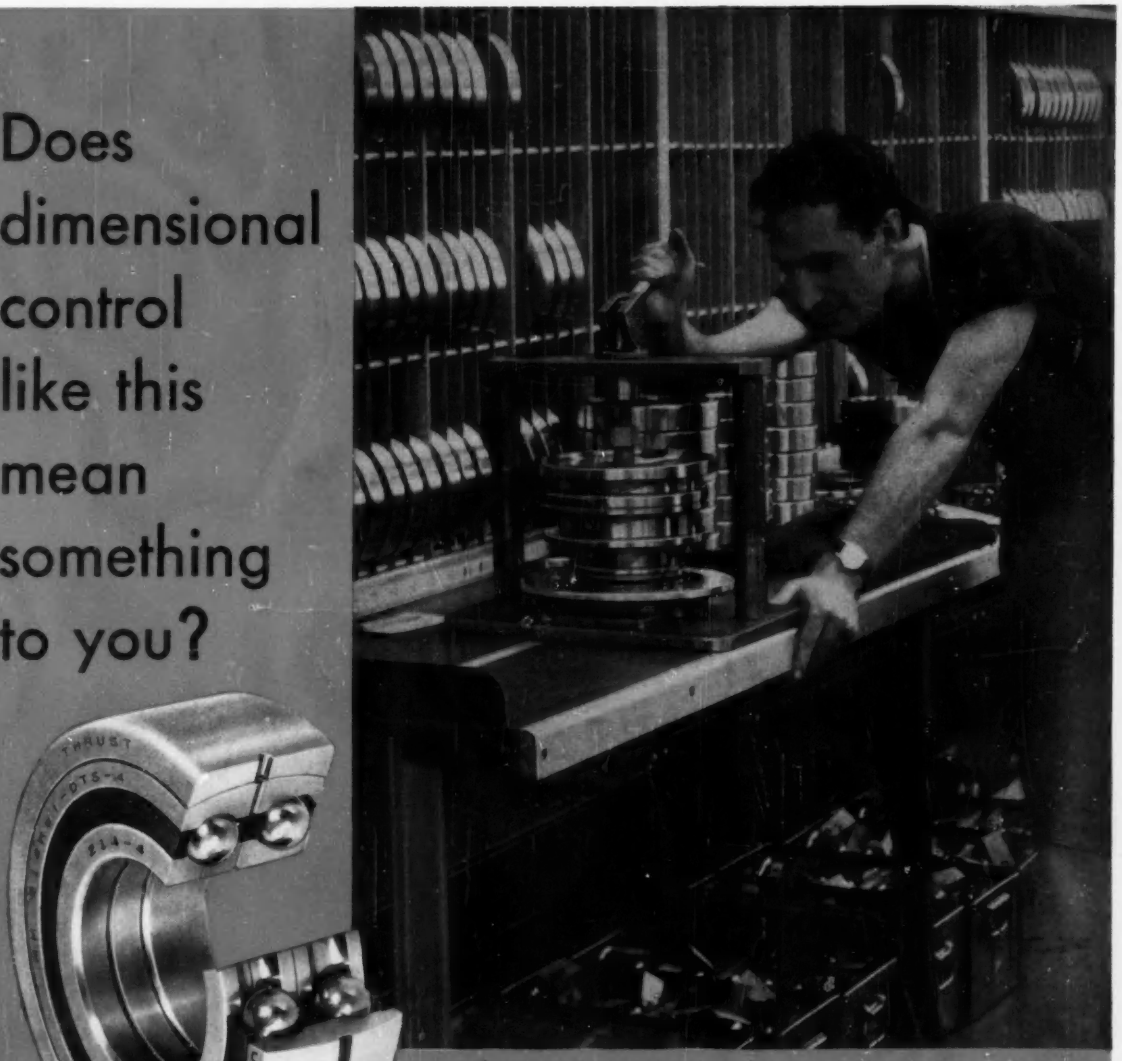


▲ Measuring the contact angle of an assembled jet engine ball bearing by rotation

◀ Fafnir Super-Precision Ball Bearing for main rotor shaft of jet engine

There is nothing typical about this measuring device or the bearing being tested, yet the ingenuity, skill, and facilities involved are available to help you solve a bearing problem or improve a bearing application.

The measuring device illustrated is a Fafnir creation developed specifically for checking the angle of contact on super-precision jet engine ball bearings. It is one of several ingenious and exclusive quality-control devices used in the super-precision division of Fafnir.

A better idea of the facilities available may be gained from the design and construction of the Fafnir jet engine bearing illustrated. Close examination reveals that this super-precision bearing involves 2 angular-contact bearings assembled in a one-piece, self-aligning type outer ring. Each component is precisely made. All must fit together and function as a super-precision unit. Jet engine bearings are tailor-made. Each requires special engineering from design to application.

The manufacture of jet engine bearings reflects the Fafnir attitude and aptitude for solving bearing problems. Perhaps this combination can help you. Contact your nearest Fafnir Sales Branch, or write The Fafnir Bearing Company, New Britain, Conn.

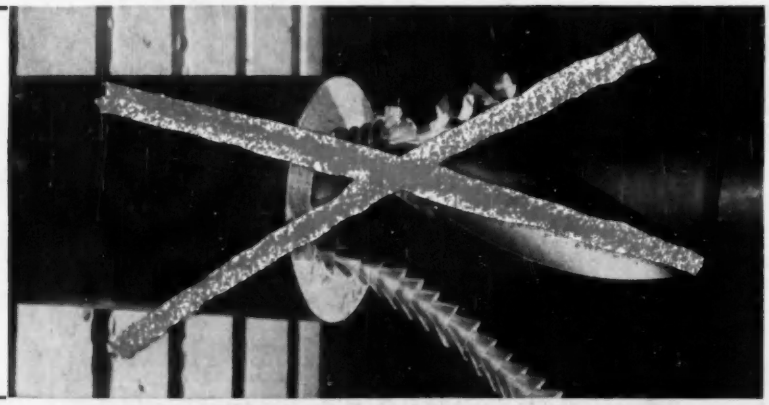
FAFNIR

AIRCRAFT BEARINGS

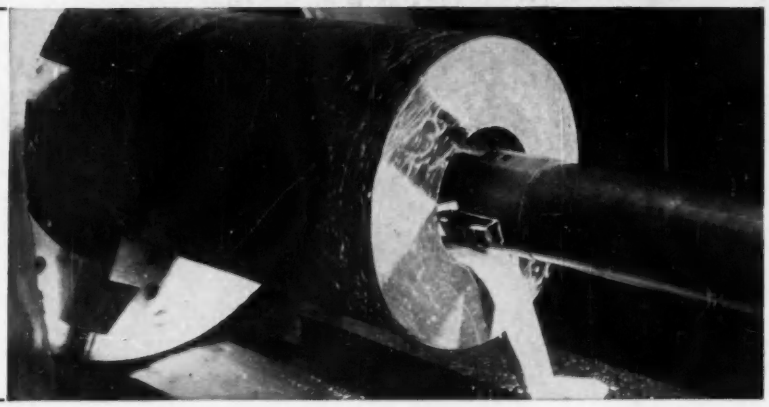
FIRST at the turning points in aircraft design

How to save a big step when you make hollow parts...

SKIP
drilling bar stock



START
with finish boring of TIMKEN® seamless steel tubing



WITH Timken® seamless steel tubing as your base stock, finish boring often is your first production operation in making hollow parts. You save a big step because you don't have to bore out the center hole. It's already there! And because Timken seamless tubing eliminates one boring operation, it frees part of your screw machines for other jobs. Result—you add machining capacity *without* adding machines.

And figure in this extra saving. With Timken seamless tubing you get more parts per ton of steel. There's less metal to hog out.

Timken Company engineers will study your problem, recommend the most economical tube size for your hollow parts job—a size guaranteed to clean up to your finished dimensions.

You can get better quality products, too. Manufacture of Timken seamless tubing is basically a forging operation. It produces a uniform spiral grain flow for greater strength—a refined grain structure that brings out the best in the metal's quality. And this quality is uniformly maintained from tube to tube, heat to heat, order to order. Our metallurgists will gladly work with you, show you where Timken seamless steel tubing can save you money. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO."

TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U.S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING